1977

Rent determination and capital/land substitution : the case of a regional city central business district

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RENT DETERMINATION AND CAPITAL/LAND SUBSTITUTION: THE CASE OF A REGIONAL CITY CENTRAL BUSINESS DISTRICT

by

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A dissertation submitted for the degree of Doctor of Philosophy in the University of Wollongong.

To,

Mum and Dad

ACKNOWLEDGEMENTS

It is difficult to know just where to begin to express my appreciation to the people who have, in some way, helped me to finish this research. First and foremost I am extremely grateful to my supervisors Professor K. A. Blakey and Dr. R. Robinson, of the University of Wollongong, who aided with advice and criticism at many stages of the research and who then found time to be subjected to, and to comment on, an entire draft of the thesis. Dr. Brian Bentick, Faculty of Economics, University of South Australia, read the entire thesis and offered numerous valuable criticisms and suggestions for improvement (particularly in Chapters six, ten and eleven), for which I gladly offer my thanks and appreciation. Dr. R. Knight, Faculty of Economics, Case Western Reserve University, Cleveland, Ohio, also read the entire thesis and similarly offered a number of suggestions for improvement (in particular the need to consider demand as discussed in Appendix B). I willingly offer my thanks for this assistance. A number of people offered advice and comment on various parts of the work. In particular, I would like to thank Mr. E. Chapman, Lecturer, Department of Mathematics, University of Wollongong, whose comments (on the mathematics) were greatly appreciated. I have also benefited from the discussion and comment from Dr. C. Gulati, Lecturer and Dr. A. Smith, Senior Lecturer in Statistics, Mr. P. Castle; Lecturer in Mathematics, Mr. A. Partridge and Mr. A. McGregor, Lecturers in Quantitative Methods, Mrs. J. Irving, Lecturer in Economics, all of the University of Wollongong; Mr. D. Gallagher, Lecturer in Economics, University of New South Wales; and Mr. G. Runeson, Lecturer in Economics, Victoria University, New Zealand. Thanks also go to the following people for their assistance in computer programming: Dr. G. Doherty, Lecturer in Computer Science, University of Wollongong; Mr. & Mrs. R. Robinson, and Mr. T. Nunan, Systems Analysts, Australian Iron and Steel. The changeover of computers at the University of Wollongong necessitated the use of a number of computers in the analysis and I would like to thank the institutions concerned - the University of Wollongong and A.I.S.* Some 26,000 data cards were used in the research and Mrs. A. Weir willingly undertook the task of punching most of these. Mr. Chessel and Mr. P. Frolich and their staff at the Department of the Valuer General were always co-operative as were Mr. K. Dunn, Mr. M. Healey, and Mr. J. Vickers at the Town Planning Department, Wollongong City Council. My thanks also go to a number of developers, architects, builders and real estate agents - many of whom remain anonymous - for the information they provided. Last, but not least, I would like to thank my typists, Mrs. Y. Houben and Mrs. L. Hunter for turning a very messy original into a presentable thesis. Needless to say the remaining errors are my responsibility.

* The regression analyses in Chapter three were undertaken on an IBM 360. The regression and correlation analyses in Chapter six were undertaken on an IBM 1620 (the original computer at the University of Wollongong). All other analyses were carried out on a Univac 1106.

ABSTRACT

The initial impetus for an examination of the Wollongong property market, in particular land value determination in Wollongong, arose from a concern which the writer had about the efficiency (or apparent lack of it) of the property market, as reflected in the growth in the quantity of vacant commercial floor space (in the central business districts of Australian cities) at a time when residential accommodation appeared to be in short supply. The original notion was to build a model simulating supply/demand characteristics in order to better understand the property market mechanism, especially the supply side. This notion has not been fulfilled simply because there were too many questions which established theory (or lack of it) failed to deal with adequately to allow any semblance of a simulation model. In particular two problems stood out, and it is these which the research has attempted to deal with:

1) established land value theory appeared unable to offer a satisfactory explanation for the land value pattern in the Wollongong central business district (and hence appeared to have limited usefulness for predictive purposes there);

2) the literature appeared to offer little in the way of either establishing what may be regarded as an 'appropriate' committment of capital to a site in the central business district, or in specifying the interrelationship between the quantity of capital committed to be site and the inherent value of that site.

Since the problem of land value determination is crucial to the entire exercise it is introduced in Part I. Chapters one and two present what may be termed conventional land value theory. This theory is concerned with the spatial characteristics of the market, in particular the influence which location has on the determination of land values. The established (conventional) argument for land value variation may be framed basically as follows: the potential volume of business will decline (under certain assumptions) away from the focal point (in terms of traffic) of the central business district, since the volume of pedestrian traffic will fall off away from this point. Since the volume of potential business will be greatest at this focal point (usually the intersection of two main thoroughfares) the competition for floor space will be greatest there (ceteris paribus). Consequently land values will be greatest at this point and the location is often termed the peak land value (PLV) site. As the volume of potential business declines so too will land values. Thus land value will decrease away from the PLV site.

The land value pattern established under the assumptions of this conventional theory is tantamount to an 'ideal' pattern, a benchmark from which deviations may be gauged. This is the theme of Chapter two. The chapter discusses the adjustment to the assumptions, or new assumptions which may be necessary, to explain the land value pattern in various actual situations.

Chapter two also discusses a number of empirical studies of land value determination that have been undertaken. The distinguishing feature of these studies is that they have been broadly based, that is city oriented. In terms of theory there is nothing peculiar in this.

Nor is there anything peculiar about a study undertaken at a smaller scale - in a smaller area - such as the central business district. Other things being equal, one would expect a similar land value behaviour at this small scale, that is a fall off in land values away from the PLV site. Chapter two looks briefly at conceivable land value patterns if other things do not remain equal.

Chapter three examines the land value pattern in the Wollongong central business district to ascertain the extent to which this pattern conforms to the behaviour which one would expect under established land value theory. The examination is undertaken at two levels: i) on a central business district wide basis; and ii) on a street block basis. Established land value theory is shown to perform poorly as an explanatory basis at both 'levels'. In terms of the present research the result established at the street block level is highly important. By contracting the analysis to this scale the elimination of location as an explanatory force (within the area of analysis, that is, the street block) is largely obtained. What is the significance of this? At a large scale (e.g. city wide) location relative to some focal point is important in terms of volume of business generated. However, as the area of concern is reduced then location (relative to the city's focal point) within that area tends to become much less important. The reason for this is that as the size of the area is reduced the relative difference in volume of business between the extremities is also reduced. In a small area such as a street block, in fact, the difference in potential volume of business (as gauged by pedestrian traffic) may be so small as to be insignificant (provided, of course, the block is not unduly large, that is, does not extend beyond a 'comfortable' walking distance). If such is the case, then, the area within a street block (or some other division) effectively represents an area of similar locational desire. Within such an area, ceteris paribus, according to conventional land value theory, one would expect little or no land value variation (this does not negate the fact that firms may prefer a street block - an area of similar locational desire - closer to the PLV block rather than further away).

A large land value variation is shown to exist at the street block level in the Wollongong central business district. Given that, within any street block the influence of location has been removed (it is removed specifically in the regression analysis of Chapter three) then it may be suggested that any land value differences within the area are due to factors other than location. In Chapter three it is suggested that one such factor may be size of site differences. Contary to established theory, however, it is found that size of site may or may not be important. Furthermore it is found that where size is important the direction of influence may be positive or negative. Thus Chapter three effectively ends with a failure by established theory to explain the land value pattern in the Wollongong central business district.

Before preceeding to develop a model which will explain the land value pattern existing in the Wollongong central business district, as well as dealing with the other problems mentioned above, Chapters four and five (Part II) look a little more closely at the area which is under scrutiny. Chapter four has two purposes, one is to delimit the area and the other is to provide the reader with background material in order to establish some familiarity with the central business district for purposes of later analysis.

Chapter five assumes that the areas of similar locational desire (suggested in Chapter three) exist and sets about examining the competition for commercial floor space within such areas (in terms of the results of the analysis some justification for the assumption is established). The first part of the chapter establishes the basis of the firm's demand for floor space in a cluster (whether that cluster be an area of similar locational desire, or a larger area such as the central business district). The competition for floor space is examined by ascertaining whether positive and/or negative land use assocations exist in the Wollongong central business district (that is, which land uses do, and which do not compete consistently for available floor space). The chapter also ascertains whether there is any difference in this competitive structure between the core and planned areas of the central business district. An interesting feature of the analysis in Chapter five is the establishment of a competitive hierarchy of land use types for the Wollongong central business district. Chapter five also seeks to establish whether land uses array themselves in any discernible pattern with distance from the PLV site (in units of similar locational desire).

Part III returns specifically to the problem of land value determination. Recall from above that in Chapter three evidence is presented which indicates that conventional land value theory is, at best, insufficient (at least in Wollongong) as an explanatory basis for land value variation. The evidence suggests that this is particularly so when the horizontal expansion of the unit of analysis is confined to some (subjective) notion of a 'comfortable' walking distance (such as the street block).

However, as Chapters one and two point out, conventional land value theory provides a benchmark against which deviations may be gauged. Such deviations may be regarded as imperfections. Significantly, in contrast to a great deal of previous research work, the current research presumes that imperfections are not limited to the spatial. Specifically, Chapter six examines the impact which an imperfection in the market structure will have on rent determination. The imperfection under consideration is that of an imbalance in bargaining power between buyer (tenant) and seller (landlord). The notion of bargaining power is constrained to that of an imbalance between the supply of, and demand for, commercial floor space. In Chapter six it is assumed that, ceteris paribus, each firm operating in the central business district will have some particular quantity of floor space which will maximise its profits. This is known as the firm's optimum quantity of floor space. Within any range of floor space sizes (called a size category) there will be a number of firms whose optimum lies within this range. In the analysis it is the number of such firms within a given category, in relation to the space available, which determines the supply/demand interrelationship and consequently the bargaining power variable. The crux of the matter in Chapter six is quite simple - an excess supply will generate a bargaining power structure in favour of the tenant and vice versa. Depending on where the excess supply occurs the rental structure may be such that per unit rents will increase as size category increases, or will decrease as size category increases. Chapter six undertakes a number of empirical studies which tend to support the hypotheses advanced.

Having established the notion of bargaining power in Chapter six, Chapters seven and eight are concerned with revenue and cost variation in building construction. In particular these chapters are concerned with the manner in which revenue and costs vary as the bargaining power structure between landlord and tenant varies. In both chapters a particular functional form (for revenue and for cost) for a 'typical' building is established. The behaviour of each function is then scrutinised under differing assumptions of a bargaining power structure. Again, in both chapters, empirical tests are undertaken which lend support to the hypotheses.

The analyses of Chapters six, seven and eight are interwoven in Chapter nine to deal with the thesis problems of land value determination and intensity of site utilisation. Under a profit maximising assumption the chapter establishes a normal intensity of development. It is intensity of use (highest and best) which (ceteris paribus) gives a site its value, and a profit maximising intensity of use will establish a maximum site value. Having established the interrelationship between intensity of use and site value, the chapter goes on to explore the impact of various bargaining power structures on site value. Some very interesting findings are made in this chapter. For instance it is shown that the type of bargaining power structure will have an impact on whether the central business district sky profile is high or low. The chapter also returns to a question, first raised in Chapter three as to the relationship between value and size of site. In Chapter nine it is shown that it is quite within the scope of implications of the bargaining model developed to have a positive, or a negative, or no relationship between value and size of site.

Chapter ten continues with the problem of capital/land substitution partly dealt with in Chapter nine. The chapter unearths an apparent controversy in the literature as to whether land value is determined or is determining (with regard to intensity of utilisation). It is suggested that the 'controversy' is really a 'micro' vs a 'macro' view of the problem of intensity of utilisation. However, it is suggested that the views are interrelated. The chapter then examines, under various bargaining power structures, the impact which variations in the land factor input will have on capital/land substitution, and consequently land value.

There are two Appendices of note. Appendix A examines the impact of quantitative restrictions (imposed by the authorities) on land values and capital/land substitution. It is suggested that the impact will depend on what the market indicates is the optimal intensity of utilisation. The thesis analysis is undertaken with given conditions of demand. Appendix B points to the restrictive nature of this assumption and the need, therefore, to expand the current piece of research towards a broader consideration of demand factors.

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INTRODUCTION

Background

Early in 1972 the author became concerned about the growing quantity of unused commercial floor space in the central business districts of Australia's major cities, as this seemed to reflect an inefficiency in the market mechanism. His interest began with a rather naive idea of a price system which, allowing for fluctuations, lags, rigidities etc., should tend over the long period to allocate resources efficiently and equate marginal rates of preference with marginal cost relationships. It appeared from this viewpoint that actual allocation of land and building resources made little or no sense in terms of market factor costs and revealed preferences. For instance, it was estimated that in 1973 there would be one million square feet of vacant new commercial floor space in Sydney's central business district alone[1] - at a time when the housing industry was facing severe shortages of both labour and materials. It has been estimated that one million square feet of commercial floor space required a labour and material resource use equivalent to providing accommodation for 17,000 families.[2]

Two Obstacles

It was obvious that if in fact there was an inefficient operation of the price system here, then greater knowledge of the whole redevelopment process would be required before any meaningful policies on resource allocation could be established. To examine the system, simulation modelling was at first thought to be an appropriate analytical tool. However, to this end there were two rather perplexing stumbling blocks:

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1. Australian Financial Review, 9/3/1973.

2. Australian Broadcasting Commission Documentary, <u>The Oversupply of Office Space and Its Cost to the Community</u>, 4 Corners, 23/3/1974.

(1) Established land price theory appeared to offer little in the way of (a) explaining the spatial variation in land prices in a chosen study area (a central business district) and (b) providing a tie between land value determination and the capital gains (supernormal profits) stimulus to development/redevelopment.

(2) The literature concerning the determination of an optimum intensity of site utilisation, and the inter-relationship between intensity of utilisation and land value determination, appeared to be both sparse and vague.

The Study Area

These obstacles, then, provided the stimulus for, and became the focus of, an intensive piece of research, which is described on the following pages. Wollongong was the obvious case to use in testing *a priori* ideas concerning the effectiveness of the market mechanism because Wollongong was the most accessible study area, because the author had done previous work on the central business district and surrounding areas, and because Wollongong had a number of interesting features such as a quite volatile pattern of changing land use (discussed in Chapter five) and a scarcity of intensively utilised sites (by comparison with the major city central business districts).

Primary Data Sources

(a) The Valuers General Department

A large majority of the data utilised in the analysis were obtained from the Department of the Valuer General, both the Wollongong branch and the Fall's Creek Archives. Within the Department there were two data sources: (i) the valuation records and (ii) the owner return files. Some of the information was regarded as confidential and it was necessary to assure the officers of the Department that generally the information would only be used in an aggregate form and where this was not the case the information would not be for general publication.

For the type of analysis to be undertaken sampling was thought to be insufficient, therefore information was extracted for each property in the area within the commercial zoning (central city area) of the 1965 Town Plan. For each property the following information was obtained for the years 1958, 1962, 1967 and 1972: site value (UCV); total property value (ICV); assessed annual value (AAV); floor area per tenant; total rent per tenant; size of site; sale value and year of sale since 1957; occupation status of the property; corporate or other status and location status of the owner. The manner in which this information was coded for analysis is shown in Appendix C.

(b) The Town Planning Department

The Wollongong Town Planning Department undertook a survey of land uses in the central city area in 1957/58 and 1966/67. Apart from being committed to maps in the form of broad land use classifications the information was left in an essentially raw form in the original field books. The author was given access to these books and, for each property, precise information was extracted on the land use types occupying each floor. Information of a similar nature was obtained by the author by field survey with the aid of the 1972 Geography I class from Wollongong University. The manner in which this information was coded for analysis is shown in Appendix D. Information on lot number-street number correspondence was obtained from the Department of Rate Assessments (necessary since the same lot number occurred a number of times in the same street).

(c) Bureau of Census and Statistics

The Statistician was helpful in providing information on a district level. This will be indicated in the text.

(d) Developers, Architects and Builders

Questionnaires were forwarded to developers, architects and builders to obtain specific information on development costs. The questionnaire outlining the information obtained is shown in Appendix E. As this information was regarded as being of a very confidential nature the respondents were assured that it would only be used in an aggregate form.

PART I

LAND USE INTENSITY AND SITE VALUE DETERMINATION: SOME PROBLEMS IN AN EVOLVING THEORY

CHAPTER

CHAPTER 1

URBAN SITE RENT DETERMINATION IN A PERFECT SYSTEM

1.1 Introductory Statement

1.2 Economic Rent versus Contract Rent

1.3 Application of the Economic Rent Concept in the Urban Sphere

1.4 A Simulated Ideal Environment - An Aside

1.5 Conclusion

1.1 Introductory Statement

Analysis of the problem of urban rent has been at two levels. On one plane there has been an attempt to distil some order from the apparent chaos, to ascertain the underlying pattern - the pattern which would exist in the absence of imperfections. This approach may be likened to the removal of an observer to some point above the landscape, from where his observation is uncluttered by trees, mountains and other obstacles. Thus, this approach abstracts from the real world in an attempt to achieve a basic understanding of the problem, and incorporate this understanding in a simple model of rent determination. Label this a level one model. This approach is a necessary but insufficient step in helping one to understand, and to explain, the rent patterns in a particular area. Analysis on a second plane, then, involves incorporating variables to account for imperfections, that is for deviations from the level one model in a particular situation.

In effect the present chapter is primarily concerned with that part of the literature which approaches the problem at level one above - attempting to distil some order from the chaos, abstracting from the real world. In this regard the chapter examines the concept of economic rent and its application in the urban sphere. The discussion continues up to the writings of Alonso who carried out perhaps one of the most sophisticated analyses of the problem of urban rent determination.[1]

There is also a second aspect of the chapter. An experiment is undertaken which attempts to remove the problem briefly from the world of observed land value patterns and to try to ascertain some underlying

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1. Alonso, W., Location and Land Use, Harvard University Press, Cambridge, 1964.

land value pattern in Wollongong. The experiment attempts to create a Wollongong which conforms to some conception of the idealized environment envisaged by Alonso. However, the particular averaging process - an average for each entire concentric zone is taken as one observation, reducing the thousand or so observations for the entire CBD to a mere seven - in a sense makes the data hypothetical. The experiment is fruitful, however, in that it suggests a pattern which might emerge - if other things were equal. The extent to which other things are not equal may be gauged from the analysis of Chapter three. There the Alonso hypothesis is applied to the 'raw' observations (i.e. no averaging is applied) on a sectoral basis throughout the central business district and it is found that there is little conformity to the model.

1.2 Economic Rent versus Contract Rent

The concept of economic rent (as used here in discussing the theory of urban rent determination) originated with the writings of Ricardo and von Thunen.[1] To Ricardo, economic rent was equivalent to the surplus production, which would be obtained from the use of more fertile soil, above the return which could be obtained by applying the same resources of labour and capital to marginal land:[2]

> If all land had the same properties, if it were unlimited in quantity, and uniform in quality, no charge could be made for its use, unless it possessed peculiar advantages of situation. It is only then, because land is not unlimited in quantity and uniform in quality, and because in the progress of population, land of an inferior quality, or less advantageously situated, is called into cultivation, that rent is ever paid for the use of it. When in the progress of society, land of the second degree of fertility is taken into cultivation, rent immediately commences on that of the first quality, and the amount of that rent will depend on the difference in the quality of these two portions of land . . . rent is always the difference between the produce obtained by the employment of two equal quantities of capital and labour (Hartwell, 1971, pp. 93-5).

Although Ricardo was aware of the factor of location in the determination of rent he did not pursue this particular line of thought, but instead presented the general case where any attribute affecting productivity may determine the position of any piece of land on the rental value scale.

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1. Ricardo, D. On the Principles of Political Economy and Taxation, Reprinted in Hartwell, R. M. (ed.) Ricardo - Principles of Political Economy and Taxation, Penguin, Ringwood, 1971.

   Von Thunen 'The Isolated State' summarised in Chisholm, M. Rural Settlement and Land Use, Hutchinson University Library, London, 1962.

   It may be validly argued that the 'traditional' theory of urban rent determination had its origins in the works of these authors even although they were primarily concerned with rent determination in a predominantly agricultural society.

2. Marginalist ideas permeate Ricardo's works although he does not appear to have received any credit for this.

On the other hand, von Thunen incorporated location specifically as the major determinant of rent. His analysis started from the premise "... that the areal distribution of crops and livestock and types of farming depends upon competition between products and farming systems for the use of any particular plot of land. On any specified piece of land, the enterprise which yields the highest net return will be conducted and competing enterprises will be relegated to other plots where it is they which yield the highest return".[1]

Von Thunen's model assumed an isolated state within which there was soil of a uniform fertility. At the centre of this state there was a single city connected with the hinterland by horsedrawn cart over a level plain. From his analysis von Thunen was able to conclude that "The rent each crop can bid at each location will be the savings in transportation of its product that that site affords in contrast with a more distant site. The most distant land in cultivation yields no savings in transportation, and consequently there will be no rent at that location".[2]

In von Thunen's scheme economic rent was a spatial allocative agent. Any use which could not match the bid of an alternative use was forced to accept a more distant location.

The 'modern' conception of economic rent derives from Joan Robinson and may be defined as the surplus of income above the minimum supply price it takes to bring a factor into production.[3] Barlowe notes that -

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1. Chisholm, op.cit., p. 22.

2. Alonso, W. Location and Land Use, Harvard University Press, Cambridge, 1964, pp. 3-4.

3. Robinson, J. The Economics of Imperfect Competition, Macmillan, London, 1933, p. 102.

> As long as land is thought of as a free gift of nature, all of its earnings may be regarded as economic rent because no supply costs arise in its production. When one considers the economic nature of land resources, however, allowance must be made for the minimum supply costs associated with the development and maintenace of these resources together with such ownership maintenance charges as property taxes and insurance payments on buildings and improvements. Except for these charges, all the earnings that accrue to land resources or that theoretically should accrue to them may be classed as economic rent.[1]

Contract rent refers to the actual payments tenants make for the partial bundle of property rights transferred in the market place. This payment "... covers the minimum supply costs as well as the surplus of payment above these costs which the owner receives for leasing his property".[2] In a perfectly competitive system in which landlord and tenant have perfect knowledge and equal bargaining strength and in which there are no adjustment lags to changes in market conditions, contract rent will be equated with economic rent.[3]

1.3 Application of the Economic Rent concept in the Urban Sphere

Richard Hurd was among the first land economists to put forward a theory of rent determination directed specifically at the city.[4]

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1. Barlowe, R. Land Resource Economics, Prentice-Hall, Englewood Cliffs, 1958, p. 151.

2. ibid.

3. The notion of a divergence between contract rent and economic rent is considered briefly in the following chapter (Cf. p. 27 below).

4. Of course Marshall had earlier considered the problem of urban land value determination. He emphasised the importance of location within the city and defined 'situation value' and 'site value'. Situation value was the aggregate of money values of the special locational advantages of the site. Site value was the price obtainable if the site was cleared of buildings and sold in the open market. This site value was the aggregate of situation value and agricultural value. (Cf. Guilbebaud, C.W. (ed.) Marshall's Principles of Economics, Macmillan, London, 1961, pp. 441-442). Also, von Thunen anticipated the extension of his theory to the city. (Cf. Ely, R.T. and Wehriwein, S. Land Economics, Macmillan, New York, 1940, pp. 444-445).

His theory was based on the writings of Ricardo and von Thunen:

> As a city grows, more remote and hence inferior land must be utilised and the difference in desirability between the two grades produces economic rent in locations of the first grade, but not in those of the second. As land of a still more remote and inferior grade comes into use, ground rent is priced still higher in land of the first grade, rises in land of the second grade, but not in land of the third grade, and so on. Any utility may compete for any location within a city and all land goes to the highest bidder.[1]

Hurd argued that rent depends on location and by this he meant nearness to the point of maximum accessibility, viz. the centre of the city.[2] (Alonso criticised Hurd, amongst others, for his failure to incorporate the size of site into his analysis. Alonso argued that market equilibrium cannot be found without consideration of the size of site).[3]

Robert Haig attempted to give Hurd's model greater precision. He assumed away the geographical and transportational heterogeneity. "Ignore, for the time being, the physical conformation of the area and the unevenness of its present equipment of transportation facilities. One then has a circular plain whose centre is, of course, the point most easily reached from all points within its circumference".[4]

He viewed rent as "... the charge which the owner of a relatively accessible site can impose because of the saving in

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1. Hurd, R. M. Principles of City Land Values, Record and Guide, New York, 1924, pp. 11-12. Hurd's reasoning follows precisely that of Ricardo, but Hurd's case - in contrast to Ricardo's - is the special case in which distance is the variable.

2. ibid. p. 13.

3. Alonso, op.cit. p. 6 and p. 45. One of the few economists to consider the question of size was Marshall (Cf. Guilbebaud, op.cit. p. 448). This will be discussed below.

4. Haig, R. M. "Towards an Understanding of the Metropolis", Quarterly Journal of Economics, Vol. 40, 1926, p. 421.

transportation costs which the use of his site makes possible".[1] Haig argued that each firm was attempting to minimise what he termed "the costs of friction" by which he meant transportation costs plus site rent costs. The central sites were assigned, for a rental, to those activities which could make the best use of the location. In general, he argued, transportation costs increased with distance from the centre whilst rentals declined. The sum of the two, however, was not constant. "On the contrary, it varies with the site. The theoretically perfect site for the activity is that which furnishes the desired degree of accessibility at the lowest costs of friction".[2]

In Haig's scheme, the costs of friction increased with distance from the city centre so that proximity to the centre was highly desired.

Haig's concept received fairly wide acceptance amongst urban economists such as Doreau and Hinman[3] and Ratcliff[4], but it did not necessarily enjoy universal acceptance. Chamberlin agreed that location was a major determinant of urban rent[5], but he disagreed with the role played by transport costs "Rent is not paid in order to save transportation charges. It is paid in order to secure a larger volume of sales".[6]

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1. Ibid.

2. Ibid., p. 423.

3. Doreau, H. B. and Hinman, A. G. Urban Land Economics, Macmillan, New York, 1928.

4. Ratcliff, R. U. Urban Land Economics, McGraw-Hill, New York, 1949.

5. Chamberlin, E. H. The Theory of Monopolistic Competition, Harvard University Press, Cambridge, 1962, p. 266.

6. Ibid., p. 267.

In his explanation of rent determination Chamberlin argued that Ricardo's theory was inapplicable in the urban sphere. "There is no extensive margin in urban site rent. This concept has to do with a situation where the product of lands of different grades is sold in the same market".[1] But his conceptualisation was similar in some respects to Ricardo's:

> . . . urban rent arises from the products of lands of the same grade being sold in different markets. Low rent sites are not poorer sites in the same sense that marginal land is poorer than the best agricultural land. The costs of producing on them are not higher; rather, the market they afford is smaller.[2]

Alonso rejected Haig's 'costs of friction' hypothesis on two grounds. He argued that refinements of the theory led to the inclusion of disutility in the costs of friction. Since a dollar value could not be placed on disutility the theory was not capable of being tested. He agreed with Chamberlin's view that the revenue would vary with location and thus it was unrealistic to hold this and all other costs (except site and transport) constant.[3] In Alonso's model of the urban land market he introduced a series of simplifying assumptions the implementation of which ensured that economic and contract rent would be equated:

> The city is viewed as if it is located on a featureless plain, on which all land is of equal quality, ready for use without further improvements, and freely bought and sold. Both buyers and sellers will be assumed to have perfect knowledge of the market and to be unhampered by legal or social constraints. Those selling land will be assumed to wish to maximise their total revenue. Those buying land will be assumed to wish to maximise profits or satisfaction, according to whether they are firms or consumers.[4]

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1. Ibid., p. 268.

2. Ibid.

3. Cf. Alonso, op.cit., pp. 101-102.

4. Ibid., p. 15.

In his analysis each business firm had a family of bid price curves (BPC) and each curve was such that the firm would be indifferent (to location) anywhere along this curve. In other words, even although business volume decreased with distance from the centre, and operating costs increased, the level of profits was constant (along each curve) since the decrease in site rentals was a compensating factor.[1] The BPC is demonstrated in Figure 1 below. Alonso noted that this curve, this bid price function, bore no necessary relation to actual prices. "It is a hypothetical price-of-land-with-distance function, and might be termed an iso-profit curve. In short it merely says: if price of land varied thus with location, the firm would make the same profits at any location, and consequently it would be indifferent among locations".[2] The family of bid price curves of a given firm may or may not be similar to the BPCs of other firms. For any firm "The slope (of the BPC) will be such that the savings in land costs are just equal to the business lost plus the increase in operating costs".[3]

The bid price curve is similar in conception to an indifference curve. The BPC is an indifference curve in the sense that it indicates all price-location combinations to which the firm would be indifferent, and also a family of BPCs ". . . are single valued, do not cross, and slope downward to the right".[4] The major difference between the BPC and the 'conventional' indifference curve is that firms will prefer a lower BPC to a higher one. This is so since a higher BPC implies that,

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1. Alonso, op.cit., p. 55.
2. Ibid. p. 52.
3. Ibid. p. 55.
4. Ibid.

at that location, a higher rent is being bid. Since this is the case it will reduce the level of profits which may be earned at that location. Thus firms will prefer a lower BPC.

Although Alonso does not make it explicit, it is a relatively simple step from his analysis to ascertain how the actual price structure (P(t)) is ascertained. For instance, although firms in general will prefer a lower BPC to a higher one, that firm prepared to move to the highest BPC for a given location will capture the site. In the bidding process there will exist an upper constraint to the height of the BPC in that it is unlikely that a firm will move beyond that BPC at which zero profits will be earned.[1]

Let us consider the emergence of the P(t) curve diagramatically. Along any one BPC the firm will be indifferent to location. The firm will move to that BPC which represents a just sufficient bid to capture the site. There is an internal constraint in that the firm is unlikely to move to a BPC at which it is making a loss. Now, it would be unusual to expect different firms marketing different products (goods or services) to have similar (or the same) BPCs. The more likely situation is that the BPCs will be markedly different. Suppose the following represents the BPCs of a number of firms successful in capturing specific locations. Let the subscripts refer to different firms. Suppose also that each firm is on that BPC at which it is making zero profits (this assumption is for convenience only, it is not necessary to the analysis).

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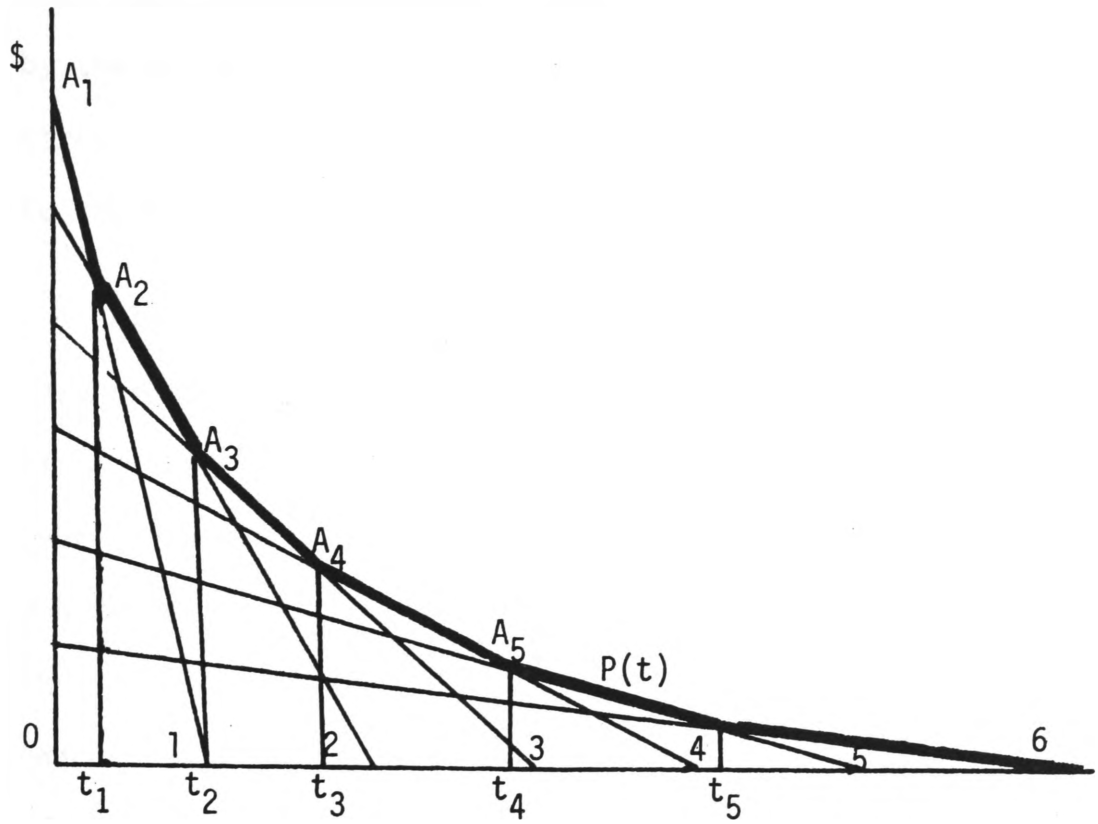
1. Cf. Alonso, op.cit., p. 56.

<u>Figure 1</u>



Now, in the above diagram firm one is indifferent regarding location anywhere between 0-1. However it has the highest BPC only between $0-t_1$, and it is only here that it will be successful in capturing a location. The actual price structure, then, will be represented by that segment of firm 1s BPC between $0-t_1$, viz. $A_1 - A_2$. The remaining segment of BPC_1 bears no relation to the actual price structure existing between t_1 and t_2 units distance from the city centre. A similar analysis may be undertaken for the remainder of the diagram. If the successful segment of each firm's BPC is joined the resulting curve will represent the actual price structure in the CBD.

Now, suppose a firm is considering a location in the CBD. If the highest BPC attainable is at all points below the price structure, ". . . the firm can operate nowhere except at a loss and will not enter the market". Now, suppose a firm considering location in the CBD is not on its zero profit BPC at all points along the actual price structure. The location at which that firm will compete for a site is determined by the point of tangency between one of its BPCs and the actual price structure curve. Of course, the actual price structure will be altered to the extent that the given firm is successful.[1]

Alonso's model also purported to take into consideration the size of the site - the size was determined once the location and price were known.[2] Since the bid rent curve indicated a constant level of profits then to stay on a particular curve given the location and the per unit price the only factor remaining to be adjusted was the size of the site. Alternatively, given the size of the site and the per unit price, location was the factor which needed to be adjusted to stay on the bid rent curve.[3]

1.4 A Simulated Environment[4] - An Aside

Perhaps one of the most sophisticated analyses of the problem of urban rent determination was that of Alonso. Alonso's particular concern was with building a 'perfect' model from which imperfections in the system could be gauged.[5] This, of course, was simple recognition

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1. The concept of competitive bidding and this notion of a feedback system is referred to again in the discussion on capital/land substitution in Chapter 10 below.

2. Ibid., p. 56.

3. The relationship between site value and size of site may not be a simple one. The thesis takes up the problem in chapters three (3.5) and Nine (9.6) below.

4. Cf. Wilson, P. J. "Land Use Structure in Downtown Wollongong", in Robinson, R. (ed.) Urban Illawarra, Melbourne, 1975.

5. Cf. Alonso, op.cit., p. 13.

of the fact that we live in an imperfect world and that imperfections - in the geographical configuration, in the market, and so on - were vital factors in urban rent determination. The present research primarily concerns itself with imperfections in the market and the impact of such imperfections on rent determination.

Wollongong, like most cities, does not conform to the hypothetical situation which exists under Alonso's assumptions. For example, in Chapter five it is suggested that the market for commercial floor space in the CBD consists of a series of sub-markets. It is argued that those activities which are not successful in obtaining a site in close proximity to the peak land value (PLV) site will locate so as to be in close proximity to those activities from which they will derive the greatest benefit.[1] 'Imperfections' such as this tend to distort the pattern that would be obtained under the Alonso conditions. The extent of the distortion in the Wollongong CBD is considered at length in Chapter three.

The pattern of land values in the CBD is, of course, structured on the land values obtained in the underlying sub-markets. Now, even although the research tends to be concentrated on rent determination in sub-markets within the CBD, it seemed worthwhile to ascertain what the broad land value pattern in Wollongong might be in the absence of distorting features. In an attempt to do this a series of concentric zones were constructed radiating from the PLV site, with the radius increasing in 300 foot "jumps" (see Map 1). In each zone the quantity

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1. See below, particularly pp. 117–130 for the abstract case and p. 130 et seq for an empirical study in Wollongong. Note that this study points to secondary economics of location, which may be due to externalities or to benefits of location in the neighbourhood (or away from the neighbourhood) or particular activities.

of usable land was totalled and divided by the total land value in order to find a value per square foot (in each zone). It was felt that the real effect of this averaging process would be to partially eliminate geographical and other imperfections for sites throughout the CBD. This procedure was carried out for the years 1958, 1967 and 1972. The exponential model[2]

$$V = ae^{bd}$$

where V = value per square foot

d = distance from the PLV site

was then tested via regression analysis using a log transformation

$$\log_e V = \log_e a + bd$$

The equations for the three years were -

<u>1958</u>

$$\log_e V = \log_e 7.69 - 0.0007D$$

Se 0.16 Se 0.00006

t 48.9 t -11.3

R^2 adjusted 0.95

F ratio 127.5

<u>1967</u>

$$\log_e V = \log_e 7.51 - 0.00060$$

Se 0.12 Se 0.00005

t 61.6 t -12.1

R^2 adjusted 0.96

F ratio 147.2

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2. Such a model has been either implied (Cf. Alonso, op.cit., or Knos D.S. "Distribution of Land Values in Topeka, Kansas", reprinted in Berry, B.J.L. and Marble, D.F. <u>Spatial Analysis</u>, New Jersey, 1968) or used (Cf. Brodsky, H. "Residential Land and Improvement Values in a Central City", <u>Land Economics</u>, Vol. 3, 1970) by previous researchers.

1972

$$\log_e V = \log_e 8.36 - 0.00060$$

Se 0.25 Se 0.00010

t 33.5 t -6.2

R^2 adjusted 0.86

F ratio 38.5

For the three years all of the regressions were significant at the one percent level of significance, as were all of the coefficients.

Unfortunately the practical usefulness of an experiment such as this to, say, the developer - whose primary concern in the CBD is the supply of floor space - is extremely limited. The experiment, which tends to eliminate special features of the market, robs him of much needed information relevant to his consideration of a profit maximising quantity of floor space to erect on a given site. For instance, the averaging process incorporated such a relatively large area in each concentric zone, that it naturally hid any differences in land values which may have arisen due to geographical or market imperfections within the zone.[1]

1. Similarly, perhaps, the averaging process utilised by Alonso (see below p.28) concealed land value variations, within the census tract, which may have arisen due to market or other imperfections (Cf. the disucssion below p.32) by Bailey, M. J. "Note on the Economics of Residential Zoning and Urban Renewal", Land Economics, Vol. 35, 1959).

1.5 Conclusion

This chapter has served to introduce the reader to the manner in which the problem of urban rent determination has been approached at an abstract level. Within this discussion, as far as later analysis is concerned, two major points of interest have been considered. Firstly, the chapter briefly highlighted the emergence of land value theory to the time of Alonso. Alonso's research was instrumental in distilling and establishing a coherent framework. As will be suggested in Chapter two, this framework effectively formed a starting point for much of the later research on land value determination - including the present work.[1]

The other major, albeit brief, point was the consideration of the concepts of both economic rent and contract rent. Much of the thesis research is concerned with testing the hypotheses put forward on rent determination. The market data utilised is, of course, based on a contract rent and it was therefore thought to be important to establish the writer's notion of the connection between the concepts of contract and economic rent. These concepts and their relationship are considered again briefly in the following chapter.

In a brief aside the chapter also undertook an experiment to test the Alonso hypothesis. A regression model utilised by other researchers

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1. However, in contrast to this later research, which was primarily concerned with those spatial imperfections that may lead to a deviation from the Alonso ideal (i.e. the pattern which would emerge , other things being equal- see the following chapter for further discussion), the present work is concerned with a market imperfection which may lead to a deviation from this ideal. (It may be argued that a spatial imperfection is but a special case of a market imperfection. However, since discussion of this possibility would serve to confuse rather than enlighten, the notion has been ignored).

was used with data which had been averaged to remove 'imperfections'. As expected these results gave strong support to the Alonso model. It was pointed out, however, that such an averaging process tends to hide special features of the market and hence tends to be of limited usefulness. In fact, in Chapter three experiments with 'untreated' data do not produce such good results.

CHAPTER 2

RENT DETERMINATION IN A NOT SO PERFECT WORLD

2.1 Introductory Statement

2.2 Economic Rent in an Imperfect System

2.3 Some Empirical Studies

2.4 Site Value Variation in a Small Area

2.5 Conclusion

2.1 Introductory Statement

Although abstractions such as those discussed in the previous chapter may be necessary to permit broad generalizations, they may do little to explain the observed variations in land values in particular situations, since, unlike any perfect world there are geographical and sociological variations, there are differences in bargaining power between landlord and tenant and so on . . . Alonso acknowledged that his model primarily provided a benchmark from which imperfections could be gauged. Thus an equally important consideration of the literature has been the introduction of variables to account for deviations from the abstract 'ideal' in particular cases.

This chapter is partly concerned with a consideration of some of the imperfections which exist in the real world and the impact which such imperfections have on the concept of economic rent. (Later chapters - cf. Part III - will be largely concerned with the influence of a particular imperfection, viz. variations in bargaining power between landlord and tenant, on urban rent determination). The present chapter also examines some of the empirical studies which have been undertaken on urban rent determination and suggests that a common feature of such studies is that they have been broadly oriented. That is, they have been concerned with land value variation over large tracts of the urban area. For purposes of the present research this may be regarded as something of a shortcoming in the literature since such an approach may tend to conceal many important features of the market, features which may be as important (if not more important) to the developer and the planner than broad, general patterns.

2.2 Economic Rent in an Imperfect System

It would be extraordinary to find a city which conformed to the ideal postulated by Haig, Alonso et al.[1] Instead the urban property market is characterised by severe rigidities. Turvey notes that:

> If the determinants of the equilibrium constellation of prices and resource use changed infrequently or slowly, while adjustments to such changes took place relatively rapidly and without much friction, the actual pattern of prices and resource allocation would usually correspond fairly closely to the equilibrium pattern. It would thus be possible to analyse the existing state of affairs in terms of an equilibrium construction. Now so far as the long run is concerned, this is not generally the case with urban property, because the great durability of buildings makes urban change a very slow process and one that is never completed.[2]

Chamberlin has pointed out that the urban property market is not a smooth functioning perfectly competitive one - there are elements of monopoly. These monopoly elements exist not only in the landlords and tenants, but in the mortgage institutions, builders and architects.[3] The transfer of resources from one use to another is not costless:

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1. Alonso did not dispute the fact that the city was characterised by imperfections. On the contrary, one of his reasons for putting forward his theory of urban rent determination was because of a dissatisfaction with the existing models from which imperfections were gauged. "There is, moreover, a strange anomaly to the discussion of imperfections of the market: namely that there is no explicit model of the "perfect" market to which these imperfections would apply". (Alonso, op.cit., p. 13).

2. Turvey, R. The Economics of Real Property, George Allen and Unwin, London, 1957, p. 47.

3. Cf. Richardson, H. W. Urban Economics, Penguin, Harmondsworth, 1971, p. 12.

> If the city is growing, the allocation of a given activity to a given site is likely to remain optimal only for a short time, yet resources are not easily transferred once they have been committed. The costs of changing sites can be very high: losses are possible on the initial investment; seeking a new location can be time-consuming and expensive; property transaction costs are high. These rigidities cannot be easily coped with by using conventional economic analysis.[1]

Imperfections also exist because of interference by public authorities. Land use zoning prohibits certain activities from specific areas irrespective of what the equilibrium pattern might be without zoning. Rent controls tend to hold rents below what they might otherwise be in the absence of controls.[2]

Furthermore, the assumption of a single focus of accessibility for the city is rarely upheld. The empirical studies of Yeates[3] and Downing[4] (discussed below) assumed several foci. Even within a given sector - particularly the central city - there may not be a single focus of accessibility. This specific case has been explained by Turvey in terms of 'special accessibility'.

> The third (factor which influences the pattern of rents) is its 'special accessibility', its nearness to particular complementary facilities. Both these types of accessibility (i.e. plus general accessibility) are matters of location, but special accessibility in contrast to general accessibility varies with the type of user. General accessibility is desired by practically all users . . . The special accessibility of a property is different for different users.[5]

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1. Ibid. p. 13.

2. Chisholm, op.cit., p. 24.

3. Yeates, M. W. "Some Factors Affecting the Spatial Distribution of Chicago Land Values, 1910-1960", Economic Geography, Vol. 41, 1965.

4. Downing, P. B. "Factors Affecting Commercial Land Values: An Empirical Study in Milwaukee, Wisconsin", Land Economics, Vol. XLIX, 1973.

5. Turvey, op.cit., pp. 48-49.

Rarely will the landlord and tenant have perfect knowledge "Sometimes the tenant has only fragmentary knowledge concerning the rent producing capacity of the land; sometimes neither party is apprized of the facts; ... the problem of inadequate knowledge causes many landlords and tenants to guess at what is a fair rental".[1] Similarly Turvey has noted that:

> Another feature of the property market which makes analysis difficult is the slowness with which rents and prices respond to changes in demand conditions. One reason for this is that it is difficult to perceive such changes. A rise in vacancies in a particular area may be the result of some chance factor or may reflect a permanent fall in demand. In the latter case it may be some time before rents or prices begin to fall, since unless the change is apparent to each individual landlord, landlords may not lower their floor rents until a long wait convinces them that they can no longer let their vacant accommodation at the rents formerly obtained. The degree of sluggishness so caused will of course vary between different kinds of property, being least where owners are best informed and where the supply is relatively homogeneous.[2]

In a system subject to the uncertainty and other imperfections mentioned above it would not be unusual to expect that lags in the adjustment of rent to market conditions would cause contract rent to diverge over time from economic rent. Economic rent in this instance would be the expected net annual rate of return to the user, or an approximation, determined by bargaining, within the range limited by the landlord's expectations and the tenant's expectations.[3]

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1. Barlowe, op.cit., pp. 167-168.

2. Turvey, op.cit., p. 26.

3. If these do not overlap in a particular instance then one party will have to adjust its expectations in the light of experience.

The economic rent will approximate contract rent at the time the contract is determined. In this case economic rent will tend to be equated with the annual cost (including normal profit) of providing and maintaining its premises, as estimated at the time of drawing up the contract. However, until a new contract is determined, economic rent may diverge from contract rent. If the economic rent should decline relative to the contract rent, that is if the tenant's expectations prove over optimistic, then he (the tenant) will find himself sacrificing some of the return that originally appeared to be due to his labour, management and capital.

2.3 Some Empirical Studies

There have been a number of studies testing the relationship between location and site rental. Some researchers have attempted to eliminate imperfections via an averaging process similar to that undertaken in Chapter one, while others have incorporated variables into their models to account for specific imperfections. A problem with such studies (including that in Chapter one) is that either the method of analysis or the scale of analysis is such that it tends to hide important features of the market, features which may help to explain land value determination at a smaller scale.[1] For instance in the following chapter it is shown (inter alia) that sites in the Wollongong CBD which appear similar in all respects may differ markedly in per unit value. What is the reason for this? This is a question which is dealt with more appropriately in later chapters, in the meantime let us look at some of the empirical studies which have been undertaken on land value determination.

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1. The scale of analysis is important because of the variation in detail required by the firm on each 'decision plane'. For instance suppose a firm is in the process of making an initial location (or relocation) decision. Theoretically, all cities enter his available choice options but are sequentially eliminated on the basis of the conditions required. Depending on the

Footnote 1 continued from page 28.

... firm and the type of business such conditions may include: available resources (including labour), markets, growth prospects, transport and so on ... Such a list of factors influencing the decision process may also contain information on land costs. But at this scale of analysis only broad comparative costs would be required since the comparison of individual sites between one city and another would be cumbersome and not very meaningful at this level. Another 'decision plane' has been reached when a particular city has been selected (the businessman may or may not be consciously aware of these 'decision planes'). At this level new factors may enter the decision process and much more detail tends to be required of those factors which also entered the decision making at the previous level. With regard to land cost the firm may require: precise information on the supply and demand for floor space as this will have a bearing on his ownership vs lease decisions, his expansion decisions, and his financing decisions; information on the 'growth' and 'decline' suburbs; to know whether the CBD is 'dying' because of suburbanisation and so on ... Thus, as the location strategy is directed towards a specific area, or a comparison between areas, more and more detail is required (as will be shown in Chapter three as the scale of analysis decreases simple use of a distance variable to assess land value variation provides only an indefinite guide to land cost). At his point it is interesting to note that land cost enters the decision process of the individual firm and his decision with regard to location and/or building expansion is influenced by this decision. In the aggregate, however, enacted decisions determine land cost which, in turn, affects individual decisions. Failure to acknowledge the distinction between the individual and the aggregate and the consequent feedback system in the property market has led to some confusion in the literature on the problem of capital/land substitution. The question is taken up and discussed at some length in Chapter ten below.

Alonso used multiple regression analysis to test for the association between amount spent on residential land with per capita income and distance from the centre of the city.[1] Although his data base was small,[2] Alonso was satisfied that he had validated his model.[3] His study considered only residential land and was on a city wide basis. The land value was based on the average for the entire census tract (with an average of 1.6 sales per tract) and the distance variable was measured from the centre of the city to the centre of the census tract.[4]

Yeates' study similarly considered only the spatial distribution of residential land values. He used a 6 independent variable regression model applied over 6 periods between 1910 and 1960. He found that the explanatory power of his model decreased significantly over that period. As regards the influence of distance from the city centre he found that "The sign of the coefficient indicates that on the whole land values do decline with distance from the Central Business District, but the standardised slope of this variable has declined by some 60 percent in the last 40 years, illustrating a decline in the attractive power of the Central Business District".[5]

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1. Alonso, op.cit., p. 125.
2. Ibid., p. 171.
3. Ibid., p. 126.
4. Ibid., p. 171.
5. Yeates, op.cit., p. 63.

Yeates suggested that the decline in attractiveness of the CBD was a major cause of the decrease in explanatory power of his model.[1]

Brodsky in examining the variation in land value with distance from the city centre found that these values declined.[2] In attempting to fit non-linear curves to the data he found that the exponential and double log functional forms gave quite good results.[3]

There have been comparatively few empirical studies dealing explicitly with the spatial variation in commercial land values. One exception is Downing's study in which he used a 10 independent variable regression model. His result with respect to distance from the CBD in the northwest sector is interesting "Thus, it appears that distance from the CBD is an important factor when the distance is substantial, but not when it is relatively short".[4]

One would normally expect that as distance from the CBD increased the effect of distance from the local commercial nucleation would take on a relatively greater role than distance from the CBD - in fact Downing's city wide results suggested this.[5]

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1. Ibid., p. 70.
2. Brodsky, H. "Residential Land and Improvement Values in a Central City", Land Economics, No. 3, 1970.
3. Ibid., p. 238. Assessment data was used due to the inadequate amount of sales data.
4. Downing, op.cit.
5. In fact one reason proffered for this unusual result was the relatively small number of shopping centres in that sector.

A common denominator in all of these studies is that they have been city oriented, that is, concerned with the variation in site rentals (of a particular land use type) throughout the city. A relatively neglected area is the analysis of rental patterns within a particular sector. One of the few studies carried out on a small sector basis has been that of Martin Bailey who looked at the influence of 'snob' appeal on residential land values in two adjacent areas. He showed how values could be bid up in a lower class area with proximity to an upper class area and vice-versa.[1]

2.4 Site Value Variation in a Small Area

The present study is also carried out very much on a small sector basis in that only the variation in land values within the CBD is considered and the street block (defined as a street between two intersections) is taken as the basic unit of analysis.[2] In view of the previous discussion let us consider the type of land value variation we might expect. Suppose the Alonso 'ideal' environment existed. In that case distance from the PLV site, as a proxy for declining volume of business, would 'explain' the variation in commercial land values irrespective of the size of the unit of analysis. The only difference in value between adjacent sites would be directly as a result of the difference in distance from the PLV site. For example suppose, in this ideal environment, there was linear regression

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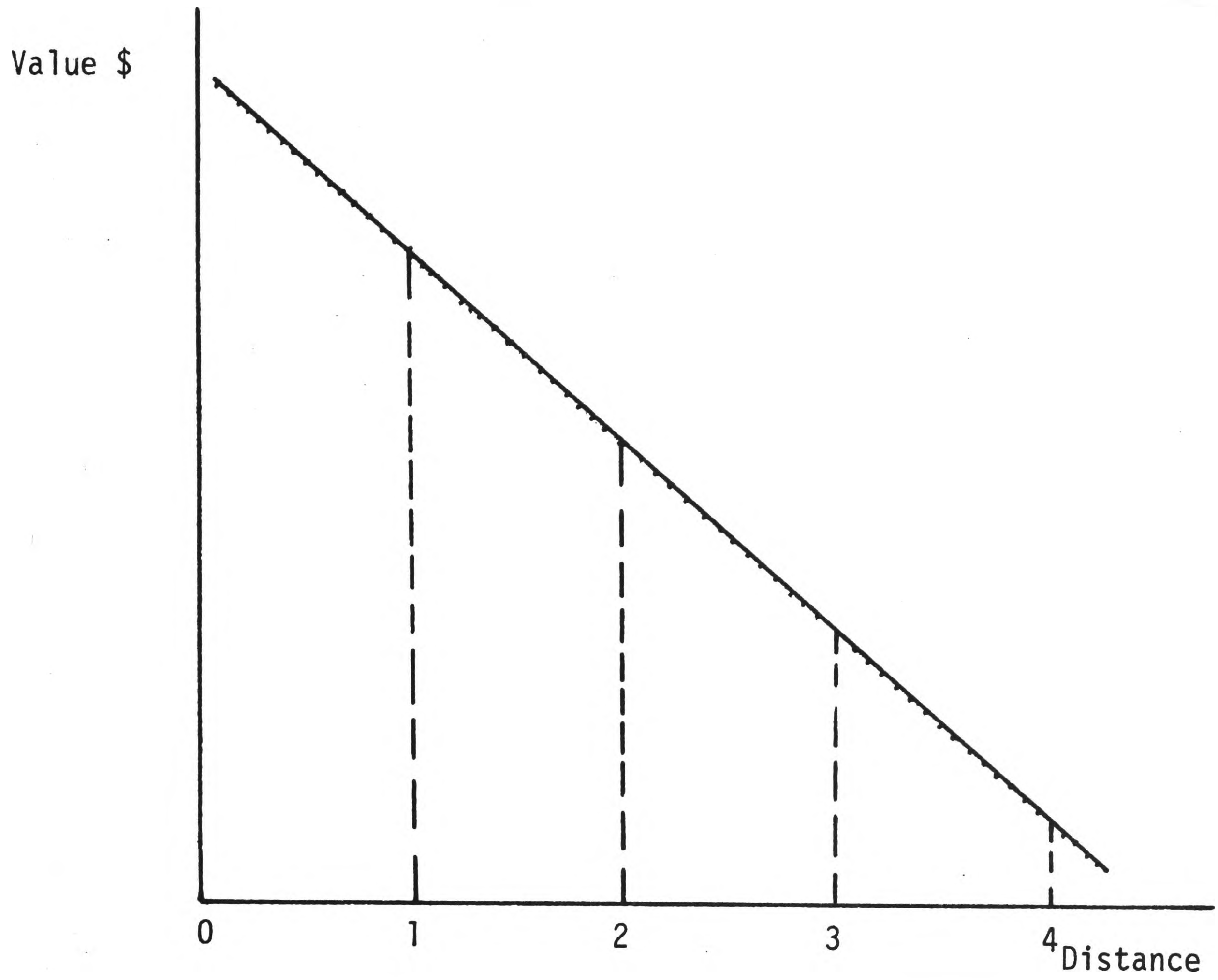
1. Bailey, M. J. "Note on the Economics of Residential Zoning and Urban Renewal", Land Economics, Vol. 35, 1959, pp. 288-291.

2. This is discussed in more detail in Chapter five below

in the population. In that case we might expect a behaviour similar to that shown in Figure 2.1.

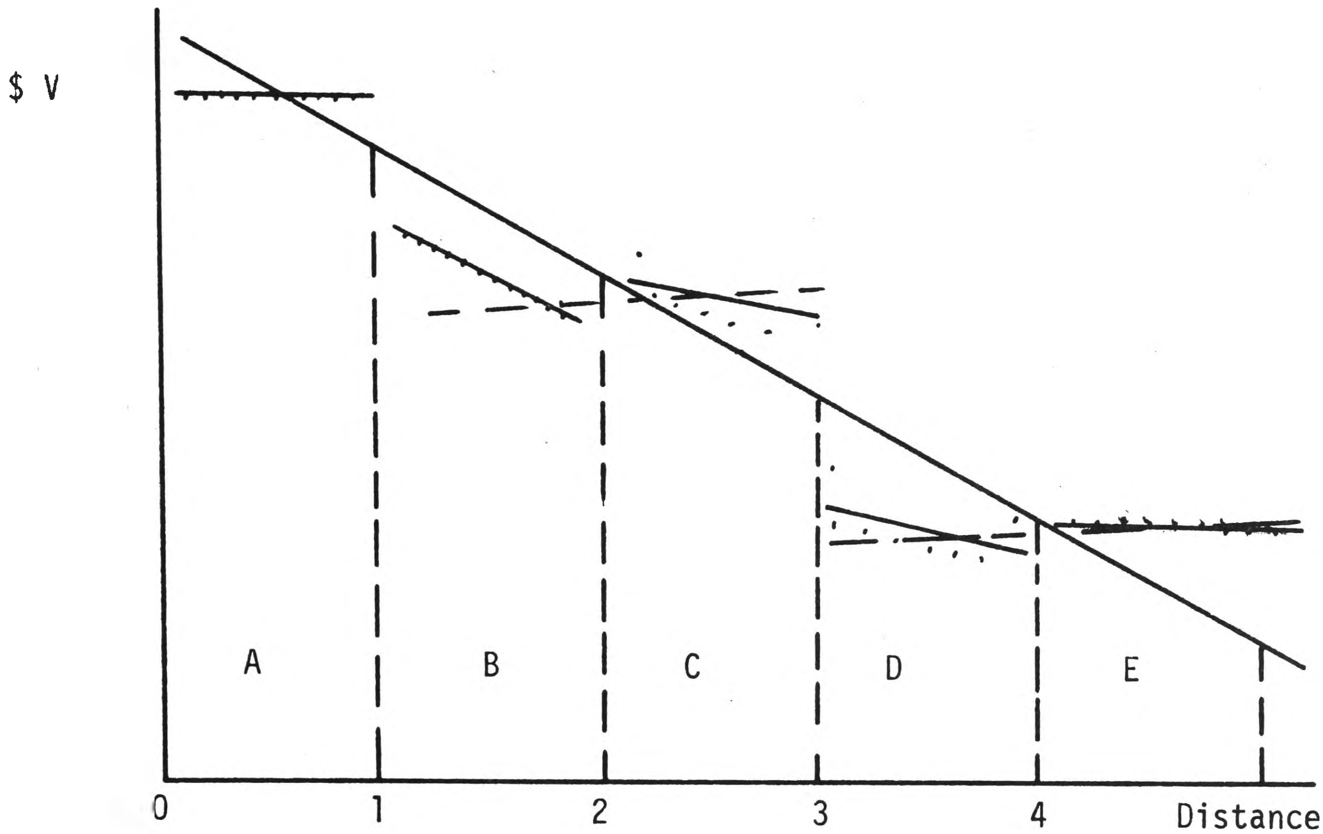
Figure 2.1



Here, irrespective of the size of the unit of analysis (i.e. whether 0-1, 0-4, etc.) distance from the PLV may be expected to 'explain' the variation in land values. There would be no dispersion about the regression line, which would slope downwards towards the periphery.

As has been pointed out, however, the Alonso 'ideal' environment is unlikely to exist in reality. In any given study area other factors may come into operation so that the influence of distance from the peak land value site may be decreased. Incorporating earlier discussion a schematic representation of what may be found in reality is presented in Figure 2.2.

Figure 2.2



A & E. It is possible that the potential volume of traffic is equal at all points along a street so that there is no decline in value (along that street) as distance from the PLV increases.

C & D. Corner influence, particularly with regard to retailing, may act to create some difference in value between corner lots and internal lots.

B - C. & D - E. There may be some 'special accessibility' factors in a particular street which cause the general level of values in that street to be higher than in some street which is closer to the peak land value site. Between such streets there may appear to be a positive association between value and distance from the peak land value site.

A - E. However there are some general results which one would expect. (1) If there is only one peak land value site then one would expect a general fall off in value away from the peak land value (PLV) site and towards the periphery (if there are a number of PLV sites, for example in those central business districts where there are different land use type nucleations, then one would expect a fall off in value towards the periphery but away from other PLV sites). (2) The smaller the unit of analysis the less dispersion one would tend to find in land values. For adjacent sites one would expect little or no difference in the per unit value of different sized sites, except that attributable to distance from the PLV site or some special accessibility points (which includes the corner).

2.5 Conclusion

There is no reason to dispute Alonso's abstract model as such[1] and, indeed, Alonso's purpose has been admirably served in that his model has provided a basis from which real world imperfections may be gauged. If the Alonso environment existed then his model may be expected to adequately explain the variation in land values irrespective of the scale of analysis. However, the literature has indicated that, at least at a city wide scale, any given urban environment tends not to

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1. As was shown in a naive fashion in section 1.4 where an attempt was made to ascertain what the pattern might be if the Wollongong data was manipulated so that it conformed to the Alonso assumptions.

conform spatially to the Alonso assumptions. Thus the literature indicated a need for (and provided) model variations to take account of this.

In the following chapter the Alonso model is applied to the actual pattern of land values in Wollongong (i.e. the values were not manipulated as in section 1.4). Anticipating some of the results of that chapter it will there be observed that little relationship was found between per unit site value and distance from the PLV site. Thus a need for model adaptation was indicated. But the intriguing question that arose - which is essentially one of the major concerns of the thesis - was: What kind of adaptation?

CHAPTER 3

THE WOLLONGONG EXPERIENCE

3.1 Introductory Statement

Alonso's research (and that of other workers) helped to establish a comparative basis for exploring particular situations - if land values in this particular area and this particular sector do not conform to some 'ideal', some norm, why should this be so? The work of Alonso, more than that of any other research worker, provided us with a basis for believing what the underlying land value pattern may be, he provided us with a theoretical 'norm' against which deviations may be compared. There are a variety of reasons why the land value patterns in a given area may not conform to the Alonso spatial model of land determination, such reasons (imperfections) were discussed in Chapter two. In this chapter an attempt is made to establish whether the actual land value pattern in the Wollongong CBD conforms to this spatial model. The result is in the negative, but an attempt to ascertain why is left for later chapters.

In Chapter one an experiment was undertaken to allow us to abstract from the observed pattern of land values in order to allow us to discern any underlying pattern. However, as was pointed out then and later, such an approach tends to hide important features of the market, details which can only be examined under a microscope. In fact, this approach tended to virtually eliminate the influence of variables other than distance from the PLV site. That is, non-spatial forces tended to be eliminated leaving only spatial forces operative. Since this is the case the basic data will not be manipulated here (as it was in Chapter one via averaging). Instead, the data will be put under a microscope by choosing a relatively small spatial unit of analysis. This will tend to reduce, or eliminate, geographical variations, as well as the locational advantage of particular sites (i.e. spatial forces). Now, if one finds land value variations which cannot be explained by any apparent remaining 'imperfections' then it may be hypothesised that such variations in land values may be attributable to the operation of non spatial forces (such as differences in size of site or other factors).

In later chapters it is hypothesised that variations in floor space rentals, and ultimately variations in land values, in small units of analysis may be attributable to variations in bargaining power between buyer (tenant) and seller (landlord).[1] In the meantime, however, this chapter establishes the existence of apparently inexplicable[2] land value variations at a relatively small spatial scale of analysis. In doing this the chapter is necessarily heavily tabulated in order to support the argument.

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1. These factors do not vary spatially.

2. In the sense that the pattern cannot be explained by spatial models of land value determination.

3.2 The Apparent Lack of Relationship Between Value and Location

Let us now consider the land value variation in central Wollongong. Table 3.1 presents the land value variation in the Wollongong CBD[1] in compact zones which, for all intents and purposes, may be regarded as being relatively homogeneous in terms of topography and internal locational advantages (each zone is 100 yards in length[2] but may not necessarily correspond to the 100 yard zones used in the simulation of Chapter one since those zones included road widths at intersections). In Wollongong's CBD, particularly in the two major commercial streets,[3] there are no sharp topographical variations, that is, any topographical variations are relatively gradual. Thus in any 100 yard zone along either of the major commercial streets the internal topographical variation will be only slight. It is not misleading, then, to say that within any such zone the topography is relatively homogeneous. Further more, since any two points within the zone can never differ in distance by more than 100 yards from the PLV point or from some special accessibility point, (in fact, if we assume 30-50 foot frontages and linear streets radiating from the PLV site, then the mean internal locational difference with respect to the PLV site ranges from 50 yards to 43 yards), neither is it misleading to speak of internal homogeneity with respect to location.

In such zones one would expect little variation in per unit area land values. Surprisingly this is not the finding as presented in Table 3.1.[4]

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1. Presentation of the precise specification of the horizontal limitations for the Wollongong CBD has been left until Chapter four. The reason for this is that there were a number of problems associated with the specification and discussion of these problems at this stage would simply interrupt the flow of presentation and would tend to disorient the reader. If required at this point, however, the area from which the data were extracted may be obtained from Chapter four.

2. Plus a slight variation to ensure that a site is not divided.

3. The 'core' area, see Chapter four below.

4. All sites in each zone were included in the analysis.

To a large extent the table summarises the land value behaviour at the adjacent site level. Column (1) indicates the par unit value range in each zone. Since the general land value level of each zone does vary as the location of the zone varies, a clearer indication of the range for comparative purposes is presented in column (2) which shows the range as a proportion of the minimum value of each zone. It may be observed that in both Crown and Keira Streets there is generally an extraordinarily large relative difference between minimum and maximum per unit values in each zone. To mention some of the outstanding cases it may be observed that in zone 1, Crown SS Keira to Darling, 1972, the maximum per unit per unit value was more than 28 times larger than the minimum value. In zone 1, Keira WS Crown to Ellen, 1958, the maximum value was more than 24 times larger than the minimum (within a mere 100 yards). To establish a visual impression of this variation let us graph the per unit value on the first 10 or 11 sites on the radius Crown SS Keira to Darling (which includes zone 1 and part of zone 2) for the year 1958. This graph is shown in Figure 3.1. Note firstly that the corner location has the second lowest site value. Note also that the lowest valued site is adjacent to the highest valued site.

Figure 3.1

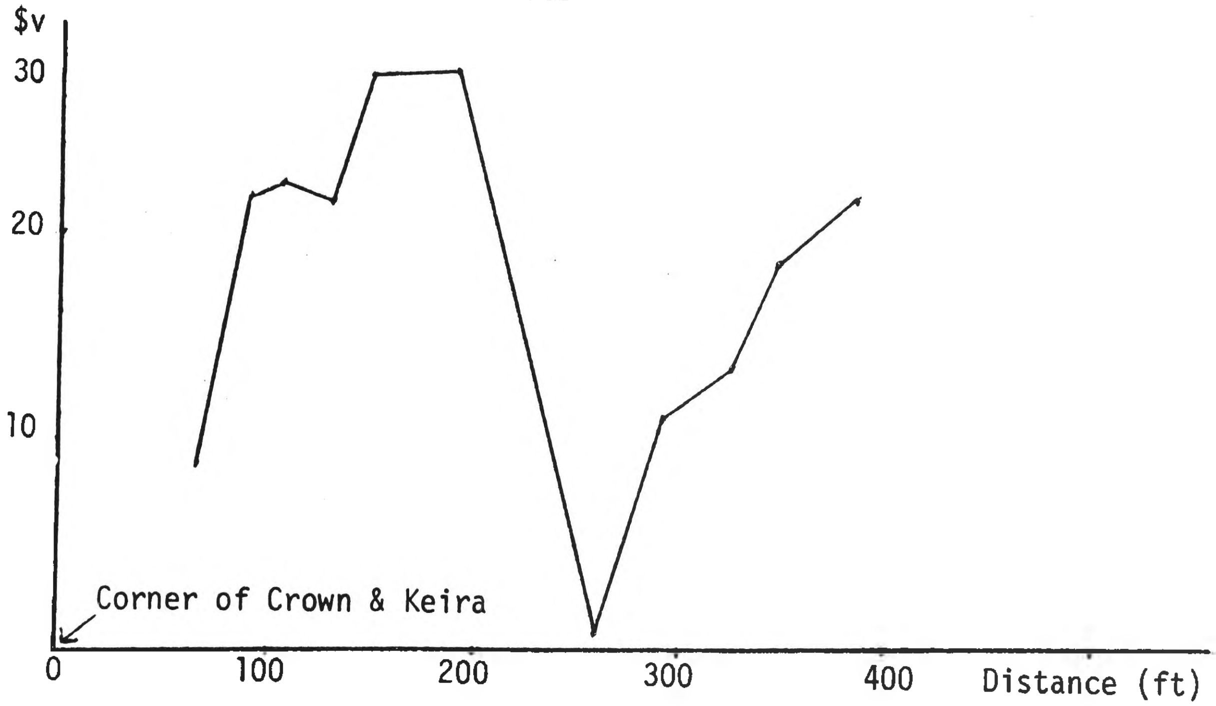

TABLE 3.1

LAND VALUE VARIATION

Crown Street (A) Keira to Darling 1958

	South Side					North Side				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Z[a]	Ra[b] ($)	Ra[c].Ptn	μ[d] $	σ[e] $	σ[f].Ptn	Ra $	Ra.Ptn	μ $	σ $	σ.Ptn
1	1.29–27.39	2023.26	20.25	6.92	34.17	10.21–26.32	157.79	21.31	4.46	20.93
2	17.06–25.22	47.83	20.55	3.42	16.64	4.36–13.46	208.72	9.34	5.26	56.32
3	7.68–17.20	123.96	13.46	2.46	18.28	6.11–24.78	305.78	12.26	8.48	69.17
4	2.97– 9.35	214.81	9.32	0.05	0.50	4.44–72.78	1539.19	24.34	32.42	133.20
5	0.71– 8.17	1050.70	5.04	3.19	63.29	1.74– 8.68	398.85	4.22	2.36	55.92
6	1.00– 1.10	10.00	1.05	0.04	3.81	0.94–15.47	1545.74	3.66	5.80	158.47
7	1.05– 1.16	10.48	1.11	0.08	7.20	0.37– 1.36	267.57	1.32	0.05	3.79
			SS	(B) Keira to Harbour 1958			NS			
1	30.36–66.90	120.36	44.80	12.20	27.23	10.31–16.41	59.16	13.18	2.31	17.53
2	23.91–41.67	74.28	27.79	17.54	63.12	15.64–34.96	123.53	17.20	8.32	48.37
3	6.45–14.15	119.38	9.02	5.11	56.65	4.10–14.00	241.46	11.24	1.18	10.50
4	7.46–15.92	113.40	11.10	3.84	34.59	3.53–15.14	328.90	8.36	4.64	55.50
5	4.66– 8.04	72.53	5.76	1.10	19.10	1.16– 5.81	400.86	4.48	1.29	28.79
6	2.66– 5.00	87.97	4.56	0.31	6.80	1.67–15.77	844.31	7.75	4.73	61.03
7						0.98– 1.54	57.14	1.26	0.28	22.22

TABLE 3.1 (cont'd.)

Z	(1) $	(2)	(3) $	(4) $	(5)	(1) $	(2)	(3) $	(4) $	(5)
			SS	(A)		1962	NS			
1	1.49-30.43	1942.28	22.98	7.17	31.20	13.80-35.28	155.65	25.16	5.09	20.23
2	19.61-25.77	31.41	22.40	2.77	12.37	5.38-16.72	210.78	11.96	3.06	25.59
3	7.60-19.11	151.45	14.97	2.96	19.77	6.04-30.99	413.08	14.80	11.07	74.80
4	4.02-10.12	151.74	9.70	0.59	6.08	7.51-88.95	1084.42	30.80	38.93	126.40
5	1.97- 8.80	346.70	7.26	2.63	36.23	3.00-10.02	234.00	6.08	2.53	41.61
6	1.97- 2.23	13.20	2.04	0.11	5.39	1.98-28.13	1320.71	6.77	10.47	154.65
7	2.11- 2.18	3.32	2.15	0.05	2.33	2.38- 2.72	14.29	2.60	0.19	7.31
			SS	(B)		1962	NS			
1	34.90-76.75	119.91	50.77	13.36	26.31	14.66-16.58	13.10	16.13	0.82	5.08
2	25.71-44.17	71.80	31.72	18.94	59.71	15.64-34.96	123.53	17.20	8.32	48.09
3	8.72-19.30	121.33	13.62	3.39	24.89	7.50-17.89	138.53	14.69	1.38	9.39
4	12.41-21.83	75.91	15.43	3.83	24.82	5.54-17.42	214.44	10.61	4.45	41.94
5	6.99-11.00	57.37	8.02	1.22	15.21	1.20- 7.26	505.00	5.44	1.98	36.40
6	4.35- 6.56	50.80	5.92	0.44	7.43	2.50-19.30	672.00	9.66	5.88	60.87
7						1.75- 2.62	49.71	2.46	0.18	7.32
			SS	Crown Street (A)		1967	NS			
1	1.47-40.64	2664.63	27.13	8.39	30.93	15.00-38.34	155.60	25.16	5.09	20.23
2	20.27-25.77	27.13	22.79	2.66	11.67	6.15-14.47	135.28	11.88	2.65	22.31
3	6.28-15.88	152.87	13.40	2.25	16.79	6.04-37.40	519.21	16.01	14.40	89.94
4	3.34- 7.79	133.23	7.76	0.04	0.52	6.57-87.60	1233.33	29.14	39.04	133.97
5	1.73-12.83	641.62	6.92	2.50	36.13	2.72- 9.64	254.41	5.56	2.36	42.45
6	1.63- 1.88	15.34	1.70	0.11	6.47	1.67-24.61	1373.65	5.89	9.18	155.86
7	1.77- 1.86	5.08	1.82	0.06	3.30	2.14- 2.39	11.68	2.23	0.08	3.59

Z	SS (1) $	SS (2)	SS (3) $	SS (4) $	SS (5)	NS (1) $	NS (2)	NS (3) $	NS (4) $	NS (5)
				(B) 1967						
1	38.78–84.68	118.36	50.88	13.27	26.08	16.75–17.62	5.19	17.36	0.35	2.02
2	27.95–48.61	73.92	42.38	8.23	19.42	16.11–37.25	131.22	19.31	7.98	41.33
3	9.18–20.16	119.61	13.59	3.44	25.31	5.42–17.92	230.63	14.66	1.40	9.55
4	12.41–21.83	75.91	15.43	3.83	24.82	7.67–15.15	97.52	10.70	3.12	29.16
5	6.41– 9.17	43.06	7.40	1.13	15.27	1.09– 6.60	505.50	5.00	1.76	35.20
6	4.35– 6.25	43.68	5.70	0.38	6.67	2.17–17.54	708.29	8.57	5.36	62.54
7						1.50– 2.29	52.67	2.16	0.16	7.41
			SS	(A) 1972			NS			
1	2.10–60.96	2802.86	35.93	12.26	34.12	19.74–50.86	157.65	38.08	13.53	35.53
2	21.26–57.86	172.15	35.26	14.71	41.72	5.14–22.30	333.85	17.24	5.12	29.70
3	9.92–27.97	181.96	22.30	4.75	21.30	8.88–53.48	502.25	22.92	20.56	89.70
4	4.51–10.51	133.04	10.46	0.08	0.76	10.43–129.38	1140.46	42.93	57.70	134.40
5	3.49–12.83	267.62	11.02	2.91	26.41	3.81–13.09	243.57	8.02	3.32	41.40
6	2.64– 3.14	18.94	2.88	0.20	6.94	3.16–39.38	1146–20	9.55	14.62	153.09
7	3.21– 3.85	19.94	3.53	0.45	12.75	3.76– 4.26	13.30	4.14	0.16	3.89
				(B) 1972						
1	54.76–142.62	160.45	81.20	29.44	36.26	39.04–39.69	1.66	39.29	0.26	0.66
2	40.81–70.08	71.72	50.81	29.95	58.95	26.58–69.90	162.98	45.18	18.27	40.44
3	11.87–36.29	205.73	18.74	4.60	24.55	9.27–29.94	222.98	20.50	10.44	50.93
4	14.85–32.77	120.67	18.05	11.73	64.99	13.01–29.48	126.59	20.44	5.88	28.77
5	4.83–12.50	158.80	6.83	5.04	73.79	0.87– 9.90	1037.93	7.38	2.86	38.75
6	5.86– 8.78	49.83	7.98	0.55	6.89	6.94–24.12	247.55	13.61	5.88	43.20
7						2.80– 4.28	52.86	3.43	0.81	23.65

TABLE 3.1 (cont'd.)

	WS				Keira Street (C) Crown to Campbell 1958	ES				
Z	(1) $	(2)	(3) $	(4) $	(5)	(1) $	(2)	(3) $	(4) $	(5)
1	3.50-16.04	358.29	10.68	6.47	60.58	13.33-21.84	63.84	15.78	3.27	20.72
2	5.81-16.28	180.21	10.28	3.82	37.16	6.06-11.00	81.52	7.27	1.65	22.70
3	3.90- 7.79	99.74	4.87	1.37	28.13	2.23- 8.59	285.20	6.15	1.81	29.43
4	1.39- 5.04	262.59	3.84	1.35	35.16	1.08- 2.01	86.11	1.31	1.14	87.02
5	1.43- 1.50	4.90	1.47	0.05	3.40					
					Keira Street (D) Crown to Ellen 1958					
1	0.60-15.46	2476.67	10.52	6.10	57.98	4.26-44.16	936.62	18.22	22.49	123.44
2	2.44- 3.39	38.93	2.92	0.36	12.33	2.50- 3.96	58.40	2.83	0.56	19.76
3	2.00- 2.97	48.50	2.75	0.36	13.09	2.30- 2.51	9.13	2.45	0.08	3.27
4	2.93- 7.42	153.24	4.72	2.22	47.03	2.39- 2.90	21.33	2.54	0.19	7.48
			WS		(C)	1962	ES			
1	6.31-18.87	199.05	12.94	6.31	48.76	12.92-22.21	71.90	15.96	2.86	17.92
2	7.10-18.72	163.66	11.91	4.46	37.45	7.58-12.99	71.37	8.85	1.88	21.24
3	4.87- 8.44	108.96	5.97	1.33	22.28	2.63-11.67	343.73	8.20	2.35	28.66
4	1.68- 6.05	260.12	4.57	1.66	36.32	1.60- 2.48	55.00	2.38	0.12	15.04
5	1.38- 2.00	44.93	1.69	0.44	26.04					
			WS		(D)	1962	ES			
1	0.65-16.11	2378.46	11.18	6.53	58.44	4.71-49-69	954.99	18.71	27.02	144.41
2	2.88- 3.05	5.90	3.01	0.07	2.33	1.31- 2.83	116.03	2.31	1.13	48.92
3	2.20- 2.97	35.00	2.76	0.30	10.87	2.46- 2.53	2.85	2.49	0.03	1.20
4	2.97- 7.42	149.83	4.95	2.32	46.87	2.39- 3.23	35.15	2.64	0.34	12.88

			<u>WS</u>	
Z	(1) $	(2)	(3) $	(4) $
1	4.08-18.87	362.50	11.82	7.42
2	5.81-17.10	194.32	10.69	4.38
3	1.51- 7.14	372.85	4.60	1.48
4	1.46- 5.21	256.85	3.89	1.43
5	1.48- 1.50	1.35	1.49	0.02
			<u>WS</u>	<u>Keira</u>
1	1.55-13.69	783.23	9.78	5.10
2	2.48- 2.50	0.81	2.49	0.01
3	2.00- 2.50	25.00	2.43	0.19
4	2.50- 6.25	150.00	4.14	1.97
			<u>WS</u>	
1	7.64-23.58	208.64	16.72	8.20
2	8.90-22.61	154.04	14.87	4.92
3	5.84- 9.96	70.55	7.39	1.59
4	4.32- 7.43	71.99	6.41	1.01
5	4.47- 5.00	11.86	4.74	0.37
			<u>WS</u>	
1	7.18-14.01	95.13	11.66	2.51
2	2.50-21.19	7.48	5.40	9.18
3	4.91- 5.08	3.46	5.02	0.08
4	4.92-42.37	761.18	12.40	13.66

TABLE 3.1 (cont'd.)

(C)	1967	ES			
(5)	(1) $	(2)	(3) $	(4) $	(5)
62.78	12.92-20.16	56.04	14.68	2.30	15.67
40.97	6.06-11.95	97.19	7.38	2.00	27.10
32.17	2.28- 9.58	320.18	6.71	1.88	28.02
36.76	1.84- 2.70	46.74	2.10	0.50	26.67
1.34					
(D)	1967	ES			
52.15	3.49-38.89	1014.33	16.07	19.79	123.15
0.40	2.25- 3.11	38.22	2.52	0.31	12.30
7.82	2.22- 2.27	2.25	2.25	0.02	0.89
47.58	2.17- 2.97	36.87	2.42	0.32	13.22
(C)	1972	ES			
49.04	12.50-28.54	128.32	15.29	5.22	34.14
33.09	6.06-11.95	97.19	7.53	2.11	28.02
21.52	3.19- 9.58	200.31	6.82	1.62	23.75
15.76	2.19- 6.38	191.32	3.85	2.19	56.88
7.81					
(D)	1972	ES			
21.53	5.30-58.17	997.55	24.31	34.10	140.27
170.00	4.14- 4.67	12.80	4.25	0.21	4.94
1.59	3.62- 4.14	14.36	3.77	0.22	5.84
110.16	3.26- 3.60	10.43	3.48	0.16	4.60

a. Z - zones in increasing distances from the plv site.
b. Ra - the range in per unit values within the zone. Note that the extreme values may not lie at the zonal boundaries.
c. Ra.Ptn - range as a proportion of the minimum value.
d. μ - mean value in the zone.
e. σ - standard deviation.
f. σ.Ptn - standard deviation as a proportion of the mean value.

Although such extremes as those above were not uncommon, the general level of difference was much lower. For instance, in Keira Street throughout the study period the mean difference between minimum and maximum values varied from about 179 percent to more than 300 percent of the minimum value. Comparable differences in Crown Street varied from about 293 percent to about four hundred percent of the minimum value (in both streets, of course, there was a high dispersion about these means).

Columns (3) and (4) show the mean per unit value and the standard deviation, respectively, in each zone. Once again, since the general level of value varies as the location of the zone varies, it was necessary to manipulate the data for comparative purposes. This was done in column (5) which shows the standard deviation as a proportion of the mean. It may be observed that, for both streets throughout the study period this proportion continued the be quite high. In about 14 percent of the cases the standard deviation was more than 50 percent of the mean value. In more than 31 percent of the cases the standard deviation was more than 25 percent of the mean value.

3.3 A Consideration of the Size of Site

What can account for this extremely high land value variation in such a limited area? (This is certainly a vital question to those whose motivation for redevelopment stems from potential capital gains). There were no significant topographical differences and there was insufficient variation in the independent variable, distance, to show a significant relationship between value and distance (this latter point was supported by the results of a series of regression analyses undertaken to test the relationship between value and distance in each zone.[1] Of the 162 zones examined over the study period in only about 11 percent of the cases was there a significant relationship between value and distance (Table 3.2 lists these zones)).

TABLE 3.2

THE RELATIONSHIP BETWEEN SITE VALUE AND LOCATION WITHIN ZONES

Street	Zone	Year	Street	Zone	Year
Crown SS	3	1958	Crown NS	3	1958
Keira to Harbour	5	1962	Keira to Darling	3	1962
	2	1967		3	1967
	5	1967		3	1972
	4	1972			
Crown NS	5	1958	Keira ES	3	1972
Keira to Harbour	5	1967	Crown to Ellen	4	1972
Crown SS	6	1958	Keira ES	1	1958
Keira to Darling	1	1972	Crown to Flinders	1	1962
			Keira WS	3	1962
			Crown to Flinders		

Even when the size of the unit of analysis was increased (from the above zonal size) to incorporate an entire street block[2] (which allowed a greater variation in the independent variable) there was not a consistent significant relationship between value and distance. For example, Table 3.3 lists the results when value was regressed against distance at the street block level. There was a relatively large variation in the independent variable distance as shown by column (2) which lists the street block length as a proportion of the entire

1. In regerssion at all 'levels' (i.e. zone, street block etc.), since site area and corner were included as variables in the same regression their influence was specifically removed from the analysis between value and distance (or whichever variable is being discussed as the independent variable). Corner was included as a dummy variable - this is further disucssed in Chapter six below.

2. For reasons discussed in Chapter five below the 'street block' is taken as the basic unit of analysis.

TABLE 3.3

THE RELATIONSHIP BETWEEN SITE VALUE AND LOCATION WITHIN STREETS

1972	(1) Code	(2) Ptn.of Rad.%[a]	(3) R^2[b]	(4) Reg.Coef.[c]	(5) Se
Crown, SS, Keira to Church	1	24	0.28*	-0.130*	0.050
" " Church to Kembla	2	27	0.04*	-0.012*	0.020
" " Kembla to End	3	29	0.21*	-0.013*	0.008
" " Keira to Railway	4	50	0.52	-0.025	0.005
" " Railway to Darling	5	51	0.68	-0.011	0.002
Crown, NS, Keira to Church	6	24	0.50	+0.057	0.022
" " Church to Kembla	7	29	0.21*	-0.018	0.008
" " Kembla to End	8	30	0.02*	+0.004*	0.007
" " Keira to Railway	9	49	0.13*	+0.030*	0.016
" " Railway to Darling	10	51	0.04*	+0.007	0.006
Keira, WS, Crown to Victoria	11	48	0.10*	-0.010*	0.016
" " Victoria to Campbell	12	52	0.76	-0.007	0.001
" " Crown to Ellen	13	100	0.01*	-0.001*	0.003
Keira, ES, Crown to Campbell	14	100	0.46	-0.025	0.011
" " Crown to Ellen	15	100	0.50	-0.002	0.001
1967	1		0.07*	-0.031*	0.029
	2		0.06*	-0.008*	0.011
	3		0.44	-0.015	0.003
	4		0.70	-0.019	0.003
	5		0.64	-0.007	0.001
	6		0.55	+0.038	0.013
	7		0.29*	-0.012	0.004
	8		0.10*	-0.006*	0.0004
	9		0.09*	+0.017*	0.011
	10		0.03*	+0.003*	0.004
	11		0.17*	-0.011*	0.014
	12		0.51	-0.005	0.001
	13		0.30	-0.005	0.001
	14		0.63	-0.010	0.001
	15		0.11	-0.007	0.003

TABLE 3.3 (cont'd.)

	Code	R^2	Reg.Coef.	Se
1962	1	0.41*	-0.058	0.020
	2	0.03*	-0.006*	0.011
	3	0.48	-0.015	0.003
	4	0.48	-0.012	0.0003
	5	0.62	-0.007	0.001
	6	0.54	+0.036	0.012
	7	0.15*	-0.010*	0.005
	8	0.09*	-0.007	0.005
	9	0.14*	+0.021*	0.011
	10	0.03*	+0.004	0.004
	11	0.09*	-0.008*	0.015
	12	0.85	-0.008	0.015
	13	0.27	-0.006	0.001
	14	0.58	-0.01	0.001
	15	0.02	-0.005*	0.006
1958	1	0.19*	-0.036*	0.021
	2	0.09*	-0.007*	0.009
	3	0.32	-0.014	0.004
	4	0.39	-0.010	0.003
	5	0.44	-0.006	0.002
	6	0.62	+0.044	0.014
	7	0.01*	-0.002*	0.003
	8	0.12*	-0.006*	0.0002
	9	0.16*	+0.019*	0.010
	10	0.01*	+0.001*	0.002
	11	0.10*	-0.007*	0.012
	12	0.72	-0.0006	0.0009
	13	0.27	-0.006	0.001
	14	0.67	-0.012	0.001
	15	0.12*	-0.008	0.004

a. Proportion of plv site - periphery radius distance.
b. R^2 for distance only.
c. Regression coefficient with the influence of site area and corner removed.
*. Not significant at the 5 per cent level.

distance from the PLV site to the periphery of the CBD (the CBD had a diameter of about a mile). In no instance was the street block length less than 24 percent of the PLV site - periphery radius. It is notable that 60 percent of the regressions were not significant at the 5 percent level of significance. Furthermore, 12 of the regression coefficients had positive signs 5 of which were significant at the 5 percent level. (Of course, as the unit of analysis approaches more of a 'macro' scale, the relationship - suggested in the literature - between value and distance tends to become more clearly established. For example, Table 3.4 lists the results obtained when value was regressed against distance when distance was allowed to vary over the entire radius of the CBD. Here only 25 percent of the streets did not have a significant relationship between value and distance - but even this is an unexpectedly high proportion).

Let us return, again, to the land value variation in each zone. At this scale an obvious factor which is not homogeneous is the size of the site. Consider, for example, Table 3.5 which lists the range, mean, and standard deviation of site area in each zone. Without dwelling on the matter it is quite clear that there was a very large variation in the size of the site in each zone.

In each zone what type of relationship may be expected between value per square foot and site area? One of the first and certainly one of the few economists to consider the problem of value and size of site was Alfred Marshall:[1] "The general relations of demand and

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1. Alonso notes that the problem of value and size has also been considered by: Beckman, J.J. "On the Distribution of Rent and Residential Density in Cities", paper presented at the Interdepartmental Seminar on Mathematical Applications in the Social Sciences, Yale University, Feb. 1957 (mimeograph); and Wingo, L. Jr. Transport and Urban Land, Resources for the Future, Washington, D.C., 1961. (Cf. Alonso, 'Location and Land Use', op.cit., pp. 14-15, fns. 24 and 25).

TABLE 3.4

1972 VALUE VARIATION OVER C.B.D. RADIUS

Street	Code	R^2	Reg.Coef.	Se
Crown, SS, Keira to Harbour	1	0.71	-0.05	0.004
" " Keira to Darling	2	0.72	-0.017	0.002
" , NS, " " Harbour	3	0.67	-0.018	0.002
" " " " Darling	4	0.04*	-0.007*	0.005
Keira, ES, Crown to Campbell	5	0.46	-0.025	0.011
" " " " Ellen	6	0.50	-0.002	0.0006
" , WS, " " Campbell	7	0.75	-0.012	0.001
" " " " Ellen	8	0.01*	-0.001*	0.003
1967	1	0.76	-0.031	0.002
	2	0.80	-0.012	0.001
	3	0.57	-0.008	0.001
	4	0.06*	-0.006*	0.003
	5	0.63	-0.010	0.001
	6	0.11*	-0.007	0.003
	7	0.71	-0.011	0.001
	8	0.30	-0.005	0.001
1962	1	0.83	-0.028	0.002
	2	0.78	-0.010	0.001
	3	0.47	-0.007	0.001
	4	0.04*	-0.005*	0.003
	5	0.58	-0.010	0.001
	6	0.02*	-0.005	0.006
	7	0.78	-0.012	0.001
	8	0.27	-0.006	0.001
1958	1	0.82	-0.025	0.002
	2	0.76	-0.010	0.001
	3	0.42	-0.006	0.001
	4	0.09*	-0.006	0.003
	5	0.67	-0.012	0.001
	6	0.12*	-0.008	0.004
	7	0.74	-0.011	0.001
	8	0.27	-0.006	0.001

* Not Significant

TABLE 3.5

SITE AREA VARIATION IN EACH ZONE[a] (SQ.FT.)

Crown Street (A) Keira to Darling

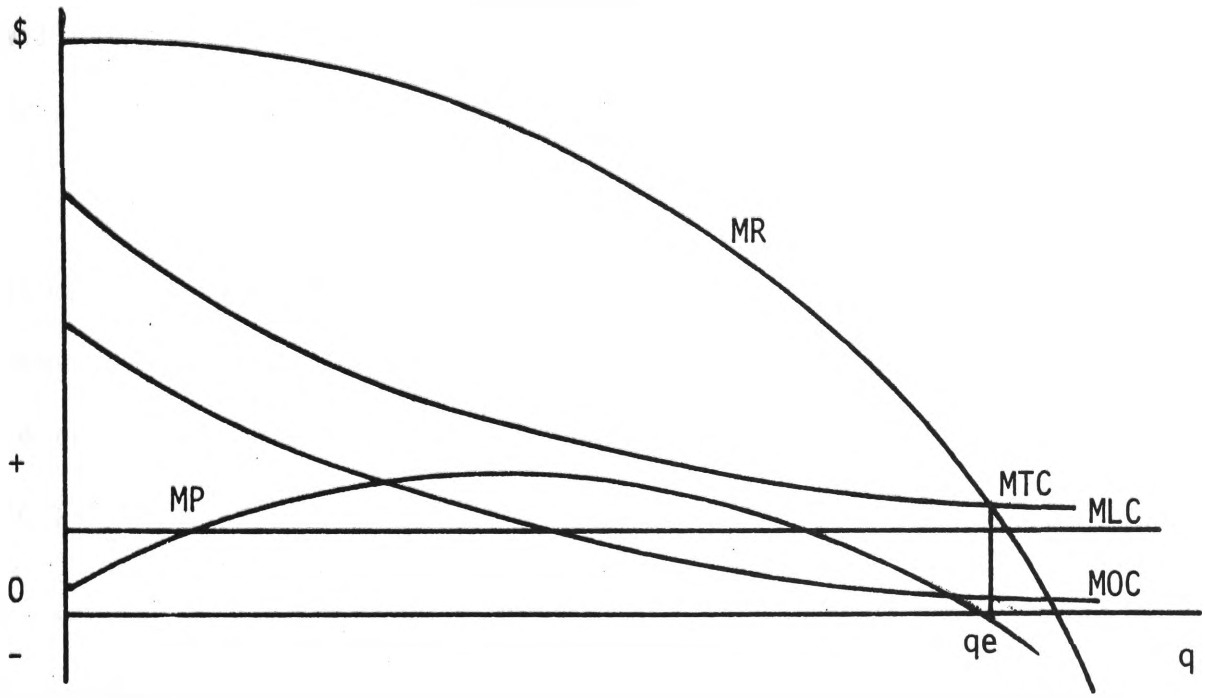
	South Side			North Side		
Z	Range	Mean	SD	Range	Mean	SD
1	2629-85370	5234	2604	1168-5194	3094	1660
2	3796-17966	10131	5486	1387-6500	3961	1965
3	1651-33778	5711	4880	2356-11700	7966	983
4	3210-42240	3480	382	742-9322	4525	3555
5	2266-33028	6677	8049	1365-9180	5098	3100
6	6080-12755	8750	2809	711-8466	6737	2964
7	6232-6232	6232	0	5875-21462	7835	3023
	Crown	(B)		Keira to Harbour		
1	930-14647	4441	4662	1940-25740	3016	1162
2	2640-12524	5637	4619	2550-12960	5866	3456
3	2480-13200	9549	3344	2533-21945	3474	1030
4	5076-11700	8985	2914	1696-19140	8470	5940
5	1680-7200	3657	2123	3085-55199	5288	3110
6	3026-32736	3844	1361	1083-7200	3238	2225
7				2400-22800	3433	1790
	WS Keira	(C)		Crown to Campbell	ES	
1	4240-44513	18011	22957	1914-7200	3771	1719
2	4960-10965	7688	2279	3471-9504	5511	2451
3	2926-7546	4869	1644	1105-18824	3879	5738
4	2741-9263	4114	1321	6463-13915	11265	4166
5	4000-10520	7260	4610			
	WS Keira	(D)		Crown to Ellen	ES	
1	945-20064	4572	5921	702-39500	3906	2799
2	3894-11900	7808	3097	5310-11357	5862	309
3	4681-12500	6669	2612	5975-6518	6189	238
4	2360-8614	4771	2451	4960-7040	5922	700

Source: Valuer General Valuation Records.

a. This information refers to 1958. There were some alterations each year due to amalgamations and subdivisions, but this table is sufficient to support the argument.

supply cause production to be carried up to a margin at which the expenses of production (nothing being entered for rent) are so high that people are willing to pay a high value for additional land in order to avoid the inconvenience and expense of crowding their work onto a narrow site".[1] Alonso considered the size of site, in relation to the problem of site rent determination, more specifically. As did Marshall, Alonso argued that a businessman will take into consideration the site area when examining his profit potential at a given location.[2] Alonso pointed out that a businessman may alter his site area, whilst maintaining the same land cost, by taking less land near the PLV site or more land near the periphery. Alonso argued that at any given location each business has an optimum quantity of land (in terms of profit maximisation) and this optimum may be ascertained as in Figure 3.2.[3]

Figure 3.2



1. Guillebaud, op.cit., p. 450.

2. Alonso, 'Location and Land Use', op.cit., p. 45.

3. Ibid., p. 47.

> First, let us assume that the businessman's location has already been fixed at $t = t_0$. The only variable he can manipulate to minimise profits will be the quantity of land, q. Marginal revenue ... will eventually decrease as q increases, and will eventually become negative when the store reaches excessive size ... Marginal costs consist of changes in operating costs ... which are shown as decreasing with economies of scale (though, of course, they may increase after the premises reach a certain size) and the marginal cost of land, which remains constant at the price of land at that location, $P(t_0)$. Total marginal costs are the sum of marginal operating costs and the marginal cost of land. The most profitable amount of land will be q_e ... where marginal costs equal marginal revenues. The ... line, indicating marginal profits, is derived by subtracting total marginal costs from marginal revenues. It is positive up to q_e, and negative thereafter. If the businessman had a smaller site than q_e. It would pay him to acquire additional land since the marginal costs would be smaller than the marginal revenue. However, he would not expand beyond q_e because marginal costs would be greater than marginal revenues.[1]

Here MTC = marginal total costs; MOC = marginal operating costs; MLC = marginal land costs; MR = marginal revenue; and MP = marginal profits. At any given location the marginal operating cost of land will remain fixed "... at the price of land at that location" irrespective of the site area used.[2]

Now, a preliminary reply may be made on the query as to the expected relationship between per unit value and site area in each zone. According to the theoretical analysis in the literature (especially that of Alonso) one would expect little or no variation in per unit value as a result of site area variation at a given location.

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1. Ibid., pp. 46-47.

2. Ibid., p. 46. Since both buyer and seller are assumed to have perfect knowledge (interalia) only the highest bid will be accepted. This bid then determines the price (and MC) of land at that location.

Such a conclusion directly contradicts the evidence to be presented below for Wollongong.

Let us briefly summarise Alonso's argument on this point. Equilibrium for the urban firm is obtained from the point of tangency between the existing price structure and the lowest bid price curve.[1] The price structure at a given location is ascertained from that firm, amongst the competing firms, prepared to offer the highest per unit price (this may, or may not be the highest bid possible from the successful firm).[2] This price structure represents the marginal cost of land at a given location and this marginal cost of land remains constant irrespective of the quantity of land taken at that location. Any firm may adjust its bid for a given site, but each time the bid is adjusted the firm will also have to adjust its conception of the optimum size of the site required to maximise profits. Given the marginal cost of land the firm will adjust the size of site required so as to maximise profits.

Let us give further consideration to Alonso's argument by way of simple examples. Suppose there is a large site on the market in the CBD, there is no reserve price and the site will sell for the highest price obtainable. Suppose also that of several potential buyers in the market some require a site of a least the size being offered, that is for these firms no downward adjustment in size is possible (without making a loss) because of the nature of the business (warehousing activities, car retailing firms etc.) while others have a minimum required size below that of the available site. The seller has the option

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1. See Chapter one.
2. Although in the long run it will tend to be the highest.

of either selling the large site or, selling several smaller sites. He will subdivide and sell smaller sites only if the bid for the smaller sites is sufficient to cover the costs of subdivision plus return a greater profit than if the site is sold undivided. Now, if the costs of subdivision are relatively minor (in Alonso's system they will, of course, be zero) the large site buyer will have to match the bid of the small site buyer if he is to acquire the site. Alternatively, suppose a small site owner decides to expand his business and needs to incorporate an adjacent small site. In that case he has to compete with other potential small site buyers for the site. If he is successful in his bid then his amalgamated large site will have the same per unit value as surrounding small sites.

If the potential large site buyer is unsuccessful in the above situations then he may relocate nearer the periphery of the CBD where the supply of suitable sites is greater and where demand pressure on all sites is less than in the 'core'. As a general observation this argument appears to be borne out. In many cites one tends to find that landuses such as warehousing and factories - which generally require large quantities of land - may locate on the periphery of the CBD.[1] If such uses wish to locate closer to the PLV site then, as Marshall notes (above) those firms will have to pay a higher price for the land in order to avoid crowding their work onto a smaller site.

Now, as suggested previously, the conclusions regarding the non variation of value with size of site directly conflict with the evidence for Wollongong (to be presented below). It may be suggested that the

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1. This is discussed further in Chapters five and ten below. Chapter ten in particular clarifies the notion of land value 'pushing' less intensive landuses towards the periphery.

TABLE 3.6

THE RELATIONSHIP BETWEEN VALUE AND SITE AREA WITHIN ZONES

Crown Street (A) Keira to Darling 1958

Z	South Side R^2	South Side Reg.Coef.[b]	South Side S_e	North Side R^2	North Side Reg.Coef.	North Side S_e
1	0.67	-0.0021	0.0006	0.94	+0.0026	0.0005
2	0.15*	+0.0002*	0.0003	0.63	-0.0009	0.0003
3	0.54	-0.0004	0.0002	0.07*	+0.0006*	0.0015
4	n			0.48*	-0.0063*	0.0046
5	0.45	-0.0003*	0.0002	0.67	-0.0006	0.0002
6	0.19	-0.00001*	0.00001	0.48	-0.0019	0.0001
7	n			0.06*	0[c]	0[c]
			Crown (B) Keira to Harbour 1958			
1	0.41*	-0.0017	0.0009	0.83	+0.0018	0.0004
2	0.90	-0.0019	0.0005	0.01*	-0.0001*	0.0010
3	0.18*	-0.0004*	0.0005	0.01*	+0.00005*	0.0004
4	0.21*	+0.0006*	0.0007	0.35*	-0.0005*	0.0003
5	0.01*	-0.00002*	0.1002	0.01*	-0.00003*	0.0002
6	0.01*	-0.00001*	0.0002	0.43	-0.0014	0.0005
7	n			0.01*	0[c]	0[c]
			(A) 1962			
1	0.71	-0.0023	0.0006	0.22*	+0.0019*	0.0016
2	0.16*	+0.0002*	0.0026	0.001*	-0.00002*	0.0006
3	0.68	-0.0005	0.0002	0.06*	+0.0007*	0.0019
4	n			0.51*	-0.0078*	0.0054
5	0.99	-0.0003	0.00003	0.83	-0.0007	0.0001
6	0.63*	+0.00003	0.00001	0.99	-0.0035	0.0002
7	n			0.13*	+0.00002*	0.00006
			(B) 1962			
1	0.20*	-0.0013*	0.001	0.32*	+0.0004*	0.0003
2	0.09	-0.0017	0.0001	0.12*	-0.0007*	0.0008
3	0.05	-0.0002*	0.0005	0.01*	-0.0001*	0.0004
4	0.17*	+0.0006*	0.0007	0.11*	-0.0003*	0.0003
5	0.05*	+0.0001*	0.0002	0.001*	-0.00002*	0.0003
6	0.01*			0.42	-0.0017	0.0007
7				0.89	-0.0001	0.00003

TABLE 3.6 (cont'd)

	WS			ES		
Z	R^2	Reg.Coef.	S_e	R^2	Reg.Coef.	S_e
		Keira (C)	**1958**			
1	0.94	−0.0003	0.0001	0.03*	+0.0003*	0.0007
2	0.04*	+0.0004*	0.0007	0.38*	+0.0004	0.0002
3	0.26*	+0.0004*	0.0003	0.59	−0.0002	0.0001
4	0.62*	−0.0008	0.0004	n		
5	n					
		Keira (D)	**1958**			
1	0.63	−0.0008	0.0003	0.99	−0.008	0.0007
2	0.06*	+0.00003*	0.0001	0.98	+0.0002	0.00002
3	0.66	−0.0001	0.00004	0.61	−0.0003	0.0001
4	0.83	−0.0008	0.0002	0.69	−0.0002	0.0001
		Keira (C)	**1962**			
1	0.84	−0.0003	0.0001	0.01*	+0.0001*	0.0006
2	0.07*	+0.0005*	0.0008	0.31*	+0.0004*	0.0003
3	0.27*	+0.0004*	0.0002	0.76	−0.0004	0.0001
4	0.62	−0.0006	0.0003	n		
5	n					
		Keira (D)	**1962**			
1	0.65	−0.0009	0.0002	0.99	−0.009	0.0004
2	0.16*	−0.00001*	0.00001	0.21*	+0.0001*	0.0001
3	0.56	−0.0001	0.00003	0.03*	+0.00002*	0.0001
4	0.76	−0.0008	0.0002	0.68*	−0.0004	0.0001
		Keira (C)	**1967**			
1	0.83	−0.0003	0.0001	0.02*	+0.0002*	0.0005
2	0.05*	+0.0004*	0.0008	0.33*	+0.0005	0.0003
3	0.20*	+0.0004*	0.0003	0.76	−0.0003	0.0001
4	0.58*	−0.0005	0.0002	0.91	−0.0001	0.00004
5	n					
		Keira (D)	**1967**			
1	0.61	−0.0007	0.0002	0.99	−0.007	0.0005
2	0.32*	0^c	0^c	0.89	+0.0001	0.00002
3	0.96	−0.0001	0.00001	0.40*	+0.0001*	0.00003
4	0.81	−0.0007	0.0002	0.59*	−0.0004	0.0002

TABLE 3.6 (cont'd)

	SS	Crown (A)		1967	NS	
Z	R^2	Reg.Coef.	S_e	R^2	Reg.Coef.	S_e
1	0.17*	−0.0013*	0.0012	0.01*	+0.0004*	0.0022
2	0.11*	+0.0002*	0.0003	0.01*	−0.0001*	0.0005
3	0.55	−0.0003	0.0002	0.04*	+0.0008*	0.0025
4	n			0.48*	−0.0076*	0.0056
5	0.99	−0.0003	0.00002	0.79	−0.0007	0.0001
6	0.69	+0.00003	0.00001	0.99	−0.0031	0.0002
7	n		n	0.02*	0^c	0^c
		(B)		1967		
1	0.24*	−0.0020	0.0012	0.40*	+0.0002*	0.0001
2	0.22*	−0.0008*	0.0008	0.10*	−0.0007*	0.0008
3	0.30*	−0.0005*	0.0014	0.01*	−0.0001*	0.0005
4	0.17*	+0.0006*	0.0007	0.05*	−0.0001*	0.0002
5	0.01*	+0.00001*	0.0002	0.01*	+0.00004*	0.0002
6	0.01*	−0.00001*	0.0002	0.43	−0.0016	0.0006
7	n			0.93	−0.00008	0.00002
		(A)		1972		
1	0.11*	−0.0016*	0.0018	0.01*	+0.0006*	0.0035
2	0.16*	−0.0011*	0.0014	0	0	0
3	0.34*	−0.0006*	0.0004	0.05*	0.0012*	0.0036
4	n			0.49*	−0.0114*	0.0082
5	0.99	−0.0004	0.00003	0.67	−0.0009	0.0002
6	0.03	+0.00001*	0.00004	0.99	−0.0049	0.0002
7	n			0.07*	+0.00001*	0.00005
		(B)		1972		
1	0.27*	−0.0038	0.0021	0.01*	−0.00001*	0.0001
2	0.99	−0.0024	0.00009	0.01*	−0.0005*	0.0016
3	0.72	−0.0016	0.0005	0.06*	−0.0006*	0.0009
4	0.36*	+0.0013*	0.0012	0.21*	−0.0005*	0.0004
5	0.002*	−0.00007*	0.0006	0.01*	+0.0001*	0.0004
6	0.01*	−0.00004*	0.0003	0.28*	−0.0014	0.0008
7				0.91	−0.00009	0.00003

TABLE 3.6 (cont'd)

	WS	Keira (C)		1972	ES	
Z	R^2	Reg.Coef.	S_e	R^2	Reg.Coef.	S_e
1	0.93	-0.0003	0.0001	0.02*	+0.0004*	0.0011
2	0.02*	+0.0003	0.0010*	0.31*	+0.0005*	0.0003
3	0.54	+0.0007	0.0002	0.69	-0.0002	0.0001
4	0.85	-0.0005	0.0001	0.70	-0.0005	0.0002
5	n					
		Keira (D)		1972		
1	0.70	-0.0004	0.0001	0.99	-0.008	0.0005
2	0.39*	-0.00004*	0.0001*	0.99	+0.0001	0.00001
3	0.001*	0^c	0^c	0.15*	+0.0004*	0.0004*
4	0.39*	-0.0035	0.0020*	0.48*	+0.0002*	0.0001*

a. R^2 with site area as the only independent variable.

b. Regression coefficient with distance from plv site and corner influence removed.

c. Coefficient had to be taken to more than 7 decimal places. In all cases the coefficient was not significant.

*. Not significant at the 5 per cent level.

n. Insufficient observations.

conflict arises due to the fact that Alonso's analysis was carried out under his assumption of a 'perfect' market.[1] In such a market there is perfect knowledge, balanced bargaining power and so on . . . Analysis in later chapters (especially Chapter nine) will show how consideration of imbalances in bargaining power between buyer and seller can lead to the sort of results found below for Wollongong.

Let us consider the relationship between value (per square foot) and site area in each of the previously defined zones. The relationship was tested via regression analysis and the results are shown in Table 3.6. Note firstly the regularity with which a relatively high proportion of the total variation was accounted for by the variation in site area. Furthermore, in spite of the hypothetical conclusions suggested above more than 37 percent of the regression equations (when site area only

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1. The nature of the market, including any restrictions imposed by the authorities, is an important consideration. For example, Turvey points out that it is conceivable that a small site in a commercial area may have a smaller per unit value than a large site if the nature of the market is such (eg. building regulations may inhibit development of a small site) that the land use potential of the site cannot be fully realised (Cf. Turvey, op.cit., p. 53). Similarly, reduced liquidity and increased risk of holding large sites may be important factors in a firm's bid for a site (The author is grateful to Dr. Brian Bentick for bringing this point to his attention).

was considered) were significant at the 5 percent level. The slope coefficients were those obtained when distance and corner had been specifically taken to account. Note that the signs of these coefficients were not consistent. About 31 percent of the regression coefficients had positive signs.

Let us now compare Tables 3.5 and 3.6. As noted previously there was generally a large site area variation in each zone throughout the study period. The sign of the regression coefficient appears to have been uninfluenced by the extent of the site area variation. For instance, a negative sign was obtained whether the variation was large (Crown SS Keira to Darling, zone 1) or whether it was small (Keira ES Crown to Ellen, zone 3). Similarly, a positive sign was obtained whether the variation was large (Crown NS Keira to Harbour, zone 1) or whether it was small (Keira ES Crown to Ellen, zone 2).

When the analysis was extended to the street block similar results were obtained, as shown in Table 3.7. Here is may be observed that about 30 percent of the regressions were significant when only site area was considered and about 18 percent of the coefficients had positive signs when the influence of distance and corner had been removed.

3.4 Conclusion

A number of intriguing results emerged from this empirical study of land values in the Wollongong CBD. Firstly, as the scale of analysis was reduced the land value pattern 'conformed' less and less to the pattern expected under the Alonso model. This was not to be expected

TABLE 3.7

THE RELATIONSHIP BETWEEN VALUE AND SITE AREA WITHIN STREETS

Code	R^2	Reg.Coef.	S_e	R^2	Reg.Coef.	S_e
1972				1967		
1	0.25*	-0.0038	0.0019	0.18*	-0.0015*	0.0009
2	0.01*	-0.0002*	0.0009	0.003*	+0.0001*	0.0005
3	0.003*	-0.0001*	0.0005	0.29	+0.0006	0.0002
4	0.01*	-0.0002*	0.0007	0	-0.00001*	0.0004
5	0.22*	-0.0004*	0.0003	0.29*	-0.0003	0.0002
6	0.01*	-0.0002*	0.0010	0.01*	-0.0001*	0.0007
7	0.10*	-0.0008*	0.0006	0.13*	-0.0005*	0.0003
8	0.04*	-0.0003*	0.0003	0.03*	-0.0002*	0.0002
9	0.07*	-0.0021*	0.0016	0.08*	-0.0016*	0.0012
10	0.46	-0.0018	0.0005	0.52	-0.0013	0.0003
11	0.05*	-0.0003*	0.0006	0.002*	-0.0001*	0.0005
12	0.03*	+0.0001*	0.0002	0	0	0
13	0.16*	-0.0008	0.0004	0.44	-0.0007	0.0002
14	0.17*	-0.0007	0.0002	0.17*	-0.0001*	0.0003
15	0	0	0	0.38	-0.0024	0.0007
1962				1958		
1	0.17*	-0.0012*	0.0008	0.32*	-0.0015	0.0008
2	0.06*	+0.0004*	0.0006	0.09*	+0.0004	0.0005
3	0.33	+0.0006	0.0002	0.31	+0.0007	0.0003
4	0.01*	-0.0001*	0.0003	0.002*	-0.0001*	0.0003
5	0.30*	-0.0003*	0.0002	0.26*	-0.0003*	0.0002
6	0.001*	-0.0001*	0.0006	0.02*	+0.0003*	0.0008
7	0.21*	-0.0007	0.0003	0.48	-0.0008	0.0002
8	0.05*	-0.0003*	0.0003	0.06*	-0.0002*	0.0002
9	0.08*	-0.0015*	0.0011	0.12*	-0.0016*	0.0012
10	0.50	-0.0014	0.0003	0.61	-0.0009	0.0002
11	0.02*	+0.0001*	0.0005	0.001*	-0.00003*	0.0004
12	0	0	0	0.03*	+0.0001*	0.0002
13	0.47	-0.0009	0.0002	0.43	-0.0008	0.0002
14	0.21*	-0.0002	0.00005	0.12*	-0.0001	0.0001
15	0.55	-0.0046	0.0010	0.38	-0.0028	0.0008

* Not significant at the 5 per cent level

since a reduction in scale implied a reduction in the diversification of conditions and thus a closer approximation to the physical environment of the Alonso assumption. Even at the broad scale of the CBD, however, there were a large number of occasions on which the Alonso model proved unsatisfactory.

In a search for some reason for this land value pattern at the reduced ('micro') scale[1] an examination of the relationship between site value and size of site was undertaken. The results of this analysis suggested that, contrary to hypothetical conclusions, site area at times appeared to be an important factor in the determination of site values at a given location. The most intriguing result, however, was that site area (at a given location) may exert a positive, a negative or no influence on value.

Consider the following as a possible explanation for the apparent failure of spatial models to explain the land value pattern within the Wollongong central business district. Factors influencing land value determination in the urban sphere may be classified into spatial and non spatial. Models of land value determination to date appear to have been almost exclusively concerned with the spatial forces in operation within the property market. Spatial models are useful, however, only if there exists some specific desired location, some point (e.g.PLV) in space. If the desired location is expanded from a point to a small area then spatial models will fail to explain any land value differences within that area since, by assumption, each point within that small area

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1. Corner influence had been considered.

tends to be equally desirable in terms of location. In other words, spatial forces are non operative within that area.[1] If land value differences occur within a desired area then, clearly, those differences are due to the operation of non spatial forces in the property market. These forces may be size of site differences,[2] or they may be other non spatial factors.

The research in succeeding chapters continues this notion that non spatial forces may explain land value variation within areas of similar locational desirability. Specifically, it is hypothesised in Chapter six that variations in bargaining power, in the market for commercial floor space, will lead to differences in per unit rents. Chapters seven through to nine then demonstrate the manner in which this non spatial force in the property market will be transferred through the market to influence site values. For instance, Section 9.6[3] makes use of the bargaining model to show that it is conceivable that a positive, negative or no relationship may exist between per unit value and size of site. Amongst other things Chapter ten examines the interrelationship between size and site, intensity of land use and value of site, and relates this to the common observation (mentioned

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1. Although spatial forces may be utilised to explain land value differences in a gradation of areas - such as with the experiment in Chapter one above.

2. As shown above, size of site differences do not appear to be a useful explanatory tool in Wollongong.

3. See p. 311 below.

in Chapter two) that less intensive land uses generally tend to locate on the periphery of the CBD. Before proceeding to that section of the inquiry (i.e. Part III), however, Chapters four and five (Part II) specify the area from which data were extracted (the Wollongong CBD) and provide justification for the small scale analysis adopted.

PART II

THE STUDY AREA - ITS DELIMITATION AND SUBMARKET COMPOSITION

CHAPTER

Part II accomplishes a number of important goals in terms of the overall research programme. Chief amongst these goals is that it introduces the reader to the study area as such. This is achieved in several ways. For instance, Chapter four delimits the Wollongong central business district paying particular attention to the core area - which is of primary interest in the thesis. Apart from defining the study area (and discussing the problems which this process involves) the chapter describes some of the more important changes in property ownership, occupancy and the returns on property investment which have taken place. Another manner in which the reader is introduced to the study area is by way of analysis of the land use structure of central Wollongong presented in Chapter five. But this is accomplished within the overall aim of that chapter viz. consideration of the demand for floor space in retail clusters.

CHAPTER 4

THE STUDY AREA

4.1 Introductory Statement

The aims of this chapter are twofold:

(a) The area from which data were extracted for the empirical analyses posed certain delimitational problems. This chapter sets out to show how these problems were solved;

(b) A second aspect of the chapter is to introduce the reader to those features of the Wollongong CBD which help to form a background to the analysis.

(a) Delimitation[1]

Previous chapters considered the question of land value determination in the CBD. Simply for the purpose of convenience (a smooth flow in presentation) the empirical analyses in those chapters ignored the problem of the precise area from which the data were extracted, so long as that area was known as the CBD. But, then, is delimitation a problem? Consider, for example, simply making use of the Town Plan delimitation of the central commercial area. This was thought to be a poor basis for analysis of the problem of land value determination (and capital/land substitution) in the CBD. The 'planned' boundaries are specified primarily on the basis of what the Town Planner (based on his experience and techniques) decides is a suitable and adequate area within which to contain commercial use. For present purposes it was thought that this might not prove to be satisfactory. Market

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1. In the present chapter 'define' and 'delimit' are used interchangeably. 'Define' means (inter alia) "mark out (limits or boundary) fix or show clearly the outline of ..." (Pocket Oxford Dictionary, Clarendon Press, Oxford, 1960, p. 211). It is in this sense that 'define' is used in the present chapter.

forces (determining commercial land use) may or may not find such an area adequate.[1] In the latter case the Town Plan boundaries may be utilised for present purposes since commercial enterprises may be expected to make relatively intense use of available area out to the specified boundary. On the other hand, however, the area allocated for commercial use may be quite adequate or more than adequate in the sense that the area actually utilised by commercial enterprises (at a given time) may be less than the area allocated. In such a case extraction of data from within the planned boundaries may result in the analysis of an area, much of which the market deems to be not yet suitable for commercial use.

This latter point was the problem which confronted the author. In considering this problem the early part of the chapter examines the notion of economic (market imposed) boundaries. It is decided that such boundaries will, at best, be a zonal rather than a linear demarcation. As one moves through this zone towards the peripheral areas, it is argued, there will be a decrease in the number of firms which find it profitable to locate in the area. The basis of the matter is, at what limit (spatially) can it be considered that there are still 'sufficient' firms in an area for that area to be thought of as part of the CBD. (The central business district of Wollongong, as such, was simply assumed to exist - the problem was to outline it spatially). The discussion ultimately leans toward a method of delimitation similar to that utilised by Murphy and Vance.[2] The analysis differs from that of Murphy and Vance in that the concept of

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1. The operation of market forces in the tendency to cluster, and hence in the demand for floor space in a commercial aggregation (such as the CBD) is considered in the following chapter.

2. See text of chapter

CBD use, as such, is abandoned (instead it is felt that a business use 'belongs' to the CBD simply if it can afford to be there). Making use of the relevant index a line is drawn around an area within which there are 'sufficient' commercial uses for that area to be thought of as forming part of the central business district of Wollongong.

(b) Background

It was thought that it would be useful at this stage to provide the reader with some background material on the Wollongong CBD relevant to the analysis. The chapter does this, for instance, by looking at land use composition and change in the Wollongong CBD - a prelude to the examination of competition for floor space between different land use types (Chapter five) and analysis of the problem of floor space rent determination within broad land use categories (Chapter six). This latter problem (Chapter six) is examined in terms of bargaining power between landlord and tenant. As a background to that (and later analyses) the present chapter also surveys the ownership/tenancy structure in Wollongong, the change in such structure (including activity in the market place), and the attractiveness of the CBD (to landlords and investors) as an investment medium.

4.2 Defining the Limits of the Central Business District.

(i) Economic limits to horizontal expansion.

The central business district (CBD), where "... one finds the greatest concentration of offices and retail stores reflected in the city's highest land values and its tallest building",[1] tends to be of limited horizontal scale. This would be the case irrespective of whether the area was also limited by physical or planned boundaries. That is, at any given point in time economic forces tend to limit the horizontal size of the CBD. If these economic boundaries tend to lie inside any physical or planned boundaries they may change over time, such change indicating the direction of 'pull' of the CBD.

Conceptually the notion of an economic boundary is simple. For the purposes of the present analysis assume that sellers are arranged in concentric circles in order of decreasing threshold sales levels from the centre. Further assume that each buyer commences his shopping trip at the centre of the CBD and visits each seller in each circle. Then, if the buyer places some value on the distance required to walk, his total travel costs within the CBD may be given by:

$$TC = \sum_{i=1}^{n} (r_i t + 2 r_i t) \qquad (4.1)$$

where r = the radial distance

t = the per unit distance costs

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1. Murphy and Vance undertook an intense study of the central business district and their results were published in a series of three articles: Murphy, R. E. and Vance, J. E. Jnr. "Delimiting the CBD", Economic Geography, Vol. 30 No. 3, 1954. Murphy, R. E. and Vance, J. E. Jnr. "A Comparative Study of Nine Central Business Districts", Economic Geography, Vol. 30 No. 3, 1954. Murphy, R. E., Vance, J. E. Jnr. and Epstein, B. J. "Internal Structure of the CBD, "Economic Geography, Vol. 31, No. 1, 1955. The quotation in the text referred to Murphy and Vance "Delimiting the CBD", op.cit., p. 189.

As distance from the central point increases, the real cost of the good to the consumer will also increase. This increase in real cost (due to inconvenience) will result in a decrease in the quantity of goods purchased. There will not be a conscious reduction in the quantity purchased by any one consumer, but rather there will be an increasing reluctance on the part of consumers to travel the required distance (to the sellers located close to the periphery). In other words as distance from the central point increases the activities become less well located in the cluster of economic activities (i.e. the activity is less accessible). The effect may be shown in a simple diagram (see Figure 4.1) Other things being equal, the price of the good at the centre of the city is OC at which point OM is sold. As distance from the centre (O) increases so too does the real cost of the good, OC + TC_i. This will result in a reduction in quantity purchased (via declining numbers of consumers). At some distance from the centre it will no longer be profitable for sellers to locate in the cluster of activities.

The concept of decreasing 'drawing power' of locations further from the centre is well established in the literature.[1] Horwood and Boyce have observed that the CBD is limited on a horizontal scale by the convenient walking distance of consumers.[2] This intangible barrier - a point beyond which insufficient business is generated to permit a seller to break even - may be called an economic boundary.

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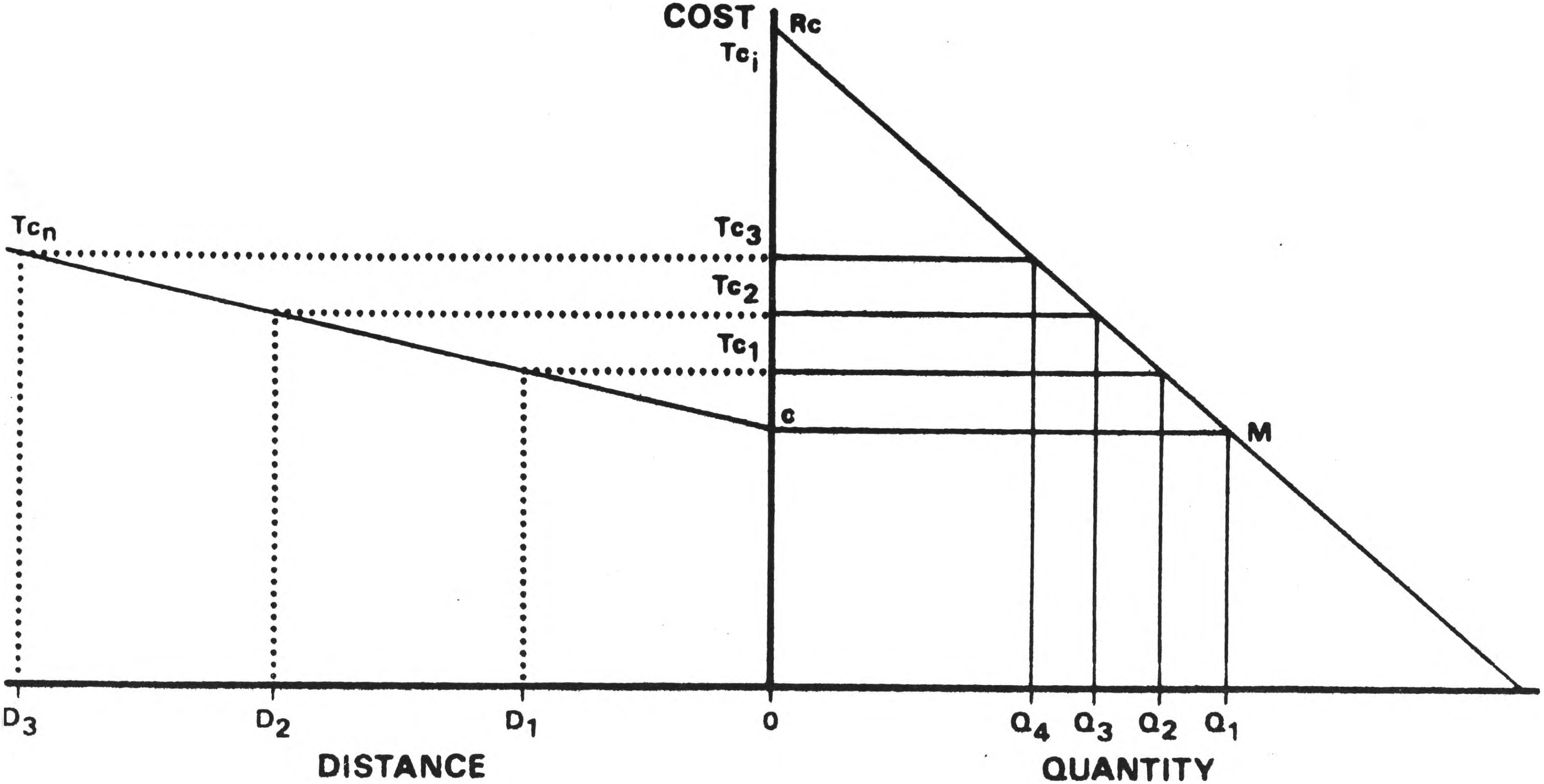
1. Cf. Alonso, Location and Land Use, op.cit., or Ratcliff, R. U. Urban Land Economics, McGraw-Hill, New York, 1949.

2. Horwood, R. M. and Boyce, R. R. Studies of the Central Business District and Urban Freeway Development, University of Washington Press, Seattle, 1959, p. 16.

Figure 4.1



Drawn by R.A.Miller, Cartographic Unit, Department of Geography, Wollongong University: from data supplied by P.J.Wilson for 'Urban Illawarra', edited by Dr.R.Robinson.

So conceptually the notion of an economic boundary is quite clear. Unfortunately it is difficult to specify since the point of economic operation will vary with different types of business activity. What will result, of course, is a zone of gradually decreasing commercial activity. This zone represents a series of economic boundaries the number depending, amongst other things, on the number of business types. Stated in this manner such a zone may be quite extensive and of little analytic value. Is it possible, then, to delimit the CBD?

(ii) Land Value Index

One potentially useful method of indicating economic boundaries is to make use of available land value data. The demand for land is derived from the use to which that land may be put. The land value will presumably reflect the site attributes and in the case of a commercial cluster the primary attribute will be the quality (in terms of potential business) of the location. Using land value data one approach would be to attribute an index of 100 to the highest valued point and express all lots as a proportion of this peak land value (PLV). The problem of having several peaks in one block may be avoided by ascribing to the peak value street block a value of 100[1] and expressing all blocks as a proportion of this peak. The assumption in this type of analysis is that "... land values form a continuum in a central region and, if sufficient values can be ascertained on a unit or front/foot basis, isopleth lines can be plotted to display the 'highs and lows', much as contours on a topographic map".[2]

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1. Cf. Davies, D. H. "Boundary Study as a Tool in CBD Analysis: An Interpretation of Certain Aspects of the Boundary of Cape Town's Central Business District", Economic Geography, Vol. 35, No. 4, 1959.

2. Horwood and Boyce, op.cit., p. 4.

A problem with using a land value index to indicate the boundary to the CBD relates to the decision on what value should be used as a cut-off point. There is no clear solution to this problem. Murphy and Vance have suggested that a 5 percent line almost coincided with the boundary set up by their dual factor score (see below). However this value is empirically derived and may change from one city to another. For instance, land value indices were calculated for each street block (defined as one side of one street between 2 intersections) in Wollongong for the 4 valuation years 1958, 1962, 1967, 1972. The indices for each block are shown in Table 4.1. Map 1 shows land values on a block-by-block basis for 1972. On Maps 2 and 3 are the 5 percent and 12 percent boundary lines respectively for each valuation year. It can be seen that the 12 percent boundary line coincides much more closely than does the 5 percent line with the boundary set up by the Murphy and Vance dual factor score.[1]

Unfortunately, since there are no strong arguments for the choice of a particular cut-off point the land value index method at present has very limited usefulness for boundary definition.

(iii) Commercial Rent Index

A similar method uses a commercial rent index derived from the shop rent index used by William-Olssen.[2] In that study the index was defined as the total of the shop rents of a building divided by the length of its frontage. In the present study a broader variety of

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1. Murphy and Vance, "Delimiting the CBD," op.cit.

2. William-Olssen, W. "Stockholm: Its Structure and Development," Geographical Review, Vol. 30, 1940.

TABLE 4.1

LAND VALUE INDEX

Street	1958	1962	1967	1972
Crown, SS, Keira to Church	1.00	1.00	1.00	1.00
" " Church to Kembla	0.27	0.33	0.30	0.29
" " Kembla to End	0.13	0.15	0.13	0.10
" " Keira to Railway	0.36	0.36	0.35	0.33
" " Railway to Darling	0.05	0.08	0.07	0.07
Crown, NS, Keira to Church	0.38	0.39	0.38	0.52
" " Church to Kembla	0.24	0.28	0.26	0.31
" " Kembla to Corrimal	0.17	0.19	0.15	0.14
" " Corrimal to End	0.04	0.05	0.04	0.15
" " Keira to Railway	0.39	0.42	0.34	0.36
" " Railway to Darling	0.08	0.12	0.10	0.10
Keira, WS, Crown to Campbell	0.15	0.16	0.12	0.12
" " Crown to Ellen	0.13	0.13	0.10	0.13
Keira, ES, Crown to Campbell	0.22	0.21	0.17	0.17
" " Crown to Ellen	0.11	0.11	0.08	0.06
Atchison ES	0.02	0.03	0.03	0.04
Atchison WS	0.03	0.03	0.03	0.05
Kenny ES	0.03	0.04	0.03	0.06
Kenny WS	0.02	0.03	0.03	0.04
Ellen NS	0.02	0.02	0.02	0.02
Church ES	0.08	0.11	0.09	0.09
Church WS	0.11	0.13	0.14	0.15
Kembla ES	0.07	0.08	0.08	0.09
Kembla WS	0.09	0.09	0.10	0.14
Corrimal ES	0.02	0.04	0.03	0.04
Corrimal WS	0.04	0.06	0.05	0.05
Railway Pde.	0.02	0.03	0.02	0.02
Governors La.	0.01	0.01	0.02	0.02
Belmore ES	0.01	0.02	0.02	0.02
Belmore WS	0.01	0.01	0.01	0.01
Young ES	0.03	0.04	0.04	0.08
Young WS	0.01	0.02	0.02	0.03

TABLE 4.1 (cont'd)

Street	1958	1962	1967	1972
Rawson SS	0.03	0.05	0.03	0.04
Rawson NS	0.01	0.02	0.02	0.02
Regent ES	0.02	0.04	0.03	0.04
Regent WS	0.02	0.02	0.03	0.03
Victoria SS	0.02	0.02	0.02	0.04
Victoria NS	0.02	0.04	0.03	0.04
Market, NS, Keira to West	0.02	0.03	0.04	0.04
Market, SS, Keira to West	0.03	0.04	0.04	0.06
Market, NS, Keira to East	0.09	0.10	0.08	0.09
Market, SS, Keira to East	0.06	0.06	0.02	0.07
Queen's Pde ES	0.02	0.02	0.02	0.02
Queen's Pde WS	0.02	0.02	0.02	0.02
Burelli NS	0.04	0.04	0.04	0.05
Burelli SS	0.05	0.07	0.07	0.11
Auburn ES	0.04	0.04	0.04	0.04
Auburn WS	0.03	0.04	0.03	0.03

commercial uses was utilised. A commercial rent index was defined as the annual rental income from commercial uses occupying a building, divided by the total area of the building in commercial use -

$$CRI = \sum_{i=1}^{n} RC_i / \sum_{j=1}^{m} FC_j \qquad (4.2)$$

where RC = rent from commercial use

FC = floor area in commercial use

CRI = commercial rent index

This index, in effect, produces an average rent per square foot of total floor space used for commercial purposes. In this form the index is of little analytical value, however, since changes in purchasing power will indicate apparent growth or contraction of the CBD. This problem may be overcome either by (i) deflating the rental values or (ii) expressing each CRI as a proportion of the peak CRI as was done in the land value index method. This calculation was carried out for Wollongong for the years 1958, 1967, and 1972, (the CRI for each block is shown in Table 4.2) and a 12 percent boundary was plotted on Map 4 for each of these years. This 12 percent boundary coincided more closely with the planned boundary than did a boundary calculated by any other method. However the CRI approach is plagued with the same problem which impaired the usefulness of the land value index - the absence of strong arguments for any particular cut-off value.

(iv) Dual factor score

Murphy and Vance have come closest to suggesting a suitable method of constructing a line which is representative of the zonal boundary to the CBD. In 1954 these authors devised a dual factor

TABLE 4.2

COMMERCIAL RENT INDEX

Street	1958	1962	1967	1972
Crown, SS, Keira to Church	1.00	1.00	0.83	0.70
" " Church to Kembla	0.49	0.56	0.81	0.72
" " Kembla to End	0.49	0.18	0.52	0.46
" " Keira to Railway	0.54	0.56	0.62	0.51
" " Railway to Darling	0.38	0.58	0.63	0.53
Crown, NS, Keira to Church	0.80	0.99	1.00	1.00
" " Church to Kembla	0.46	0.75	0.88	0.91
" " Kembla to Corrimal	0.41	0.52	0.51	0.47
" " Corrimal to End	0.63	0.55	0.53	0.46
" " Keira to Railway	0.51	0.57	0.62	0.54
" " Railway to Darling	0.25	0.32	0.30	0.35
Keira, WS, Crown to Campbell	0.55	0.53	0.56	0.45
" " Crown to Ellen	0.22	0.26	0.34	0.24
Keira, ES, Crown to Campbell	0.59	0.47	0.48	0.39
" " Crown to Ellen	0.30	0.30	0.38	0.22
Atchison ES	0.18	0.15	0.18	0.20
Atchison WS	0	0.33	0.35	0.27
Kenny ES	0	0.19	0.19	0.20
Kenny WS	0	0.32	0.30	0.24
Ellen NS	0.53	0.56	0.55	0.43
Church ES	0.47	0.62	0.61	0.35
Church WS	0.32	0.31	0.20	0.26
Kembla ES	0	0.57	0.50	0.45
Kembla WS	0.49	0.35	0.33	0.37
Corrimal ES	0	0	0	0
Corrimal WS	0.36	0.28	0.49	0.45
Railway Pde.	0	0	0	0
Governors La.	0	0	0	0
Belmore ES	0	0.86	0.84	0.57
Belmore WS	0	0	0	0.38
Young ES	0	0	0	0
Young WS	0	0	0.33	0.27

TABLE 4.2 (cont'd)

Street	1958	1962	1967	1972
Rawson SS	0	0	0	0
Rawson NS	0	0	0	0
Regent ES	0	0	0	0
Regent WS	0	0	0	0
Victoria SS	0.21	0.22	0.23	0.23
Victoria NS	0.25	0.20	0.35	0.26
Market, NS, Keira to West	0.24	0.14	0.17	0.18
Market, SS, Keira to West	0	0	0.35	0.37
Market, NS, Keira to East	0.80	0.66	0.63	0.54
Market, SS, Keira to East	0.24	0.31	0.33	0.31
Queen's Pde ES	0	0	0	0
Queen's Pde WS	0	0	0	0
Burelli NS	0	0.27	0.28	0.28
Burelli SS	0.35	0.54	0.49	0.41
Auburn ES	0.37	0.29	0.31	0.24
Auburn WS	0.14	0.13	0.21	0.22

score for delimiting the CBD.[1] Two indices were ultimately suggested:

(i) the central business height index

$$CBHI = \sum_{j=1}^{m} FC_j/S \qquad (4.3)$$

where FC = the floor space in CBD use

S = the site area

(ii) the central business intensity index

$$CBII = (\sum_{j=1}^{m} FC_j/\sum_{i=1}^{n} F_j).100 \qquad (4.4)$$

where F = the total floor space (put to any use).

The components of these indices were summed over a street block prior to calculation. A limiting value of one was placed on the CBHI "... the equivalent of a one storey building devoted to central business uses and covering the entire block", and a limiting value of 50 percent was placed on the CBII "... since it was felt that unless half of the available space was devoted to central business uses a block could hardly be considered as belonging to the CBD".[2] Thus the constraints were:

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1. Cf. Murphy and Vance, "Delimiting the CBD", op.cit. The delimitation was in an expost sense. That is, the commercial uses (to Murphy and Vance the CBD uses) already occupied the space. The authors were concerned with the problem of whether sufficient 'CBD' (in the present case 'commercial' cf. p.86 below) firms occupied a particular area for that area to be classified as being part of the CBD. Precisely what these authors thought was 'sufficient' is outlined in the above text.

2. Ibid., p. 209. Non-CBD uses were those which did not conform to some preconceived notion of what uses 'belonged' to the CBD. So that, for instance, manufacturing activities, residential uses and governmental uses were regarded by Murphy and Vance as non-CBD in character.

$$\sum_{j=1}^{m} FC_j / \sum_{i=1}^{n} S_i \geq 1 \qquad (4.5)$$

$$(\sum_{j=1}^{m} FC_j / \sum_{i=1}^{n} F_i).100 \geq 50$$

The application of these indices required the authors to institute four rules.[1] Bowden extended rule one so that "... to be included in the central business district a potential CBD block had to be connected with the core area (of contiguous CBD blocks) on at least one of its four fronts".[2] He argued that this extension was not only consistent with the theoretical view of the shape of the CBD as a tilted square,[3] but was also consistent with the Murphy-Vance empirically based view of the CBD as a quadrate cross.[4]

Indices similar to those devised by Murphy and Vance have been adopted in the present study. However, in the present analysis all of the CBIIs were equated to one hundred for two reasons. Firstly the concept of CBD use, as utilised by Murphy and Vance, was abandoned. It was thought to be incorrect to speak of a CBD use as such. Any commercial use 'belongs' to a CBD if it can afford to be there. Whether a use can afford to belong will depend on a number of factors, perhaps the most important of which will be the market area of the city.

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1. Ibid., p. 219.

2. Bowden, M. J. "Downtown Through Time: Delimitation, Expansion and Internal Growth", Economic Geography, Vol. 47, No. 2, 1971, p. 125.

3. Cf. Hartman, G. W. "The Central Business District - A Study in Urban Geography", Economic Geography, Vol. 26, 1950.

4. This suggests nothing more than that development tends to be primarily along the main streets.

As the city grows the population will reach threshold levels for different land use types (or for larger versions of the same land use type). If the CBD is the most favourable location then such 'new' uses may displace (via competitive bidding for available space) the existing 'CBD uses'. Secondly, there were single dwelling units occupying sites close to the 'heart' of the business district for which floor space information was not available (or rarely available). Because of this incompleteness residential space did not enter the index. Therefore, in formulation 4.4, since commercial use (in the CBD) and 'CBD use' were considered to be one and the same thing, and since residential use did not enter the index, FC was equated with F (by definition) and thus all of the CBIIs were equated to one hundred. For present purposes, then, the only Murphy-Vance index of any practical use was the CBHI (see Table 4.3). Now, the nature of early development in the CBD was such that often not more than 50 percent of the site was utilised (i.e. was covered with a building). Therefore a constraint of CBHI > 0.5 (for the entire block) was adopted.

Map 5 indicates boundaries for the years 1958, 1967 and 1972 based on this method (the indices are shown in Table 4.3). The CBD is confined to the two main throughroutes of Crown and Keira Streets throughout most of the period. In fact the indices suggest that there was relatively little change in the boundaries throughout the study period.

However the indices did not remain completely stable throughout the period. Of the fringe areas outside the core the area of primary expansion appeared to be south of Crown Street, particularly Auburn ES,

TABLE 4.3

MURPHY/VANCE CBHI*

Street	1958	1962	1967	1972
Crown, SS, Keira to Church	0.94	1.58	2.48	2.47
" " Church to Kembla	0.68	0.83	0.91	0.92
" " Kembla to End	0.35	0.37	0.37	0.38
" " Keira to Railway	1.20	1.16	1.24	1.28
" " Railway to Darling	0.07	0.43	0.44	0.44
Crown, NS, Keira to Church	0.57	0.61	0.62	0.51
" " Church to Kembla	0.42	0.60	0.60	0.67
" " Kembla to Corrimal	0.40	0.46	0.86	0.48
" " Corrimal to End	0.17	0.17	0.17	0.17
" " Kiera to Railway	0.73	1.10	1.09	1.09
" " Railway to Darling	0.26	0.26	0.26	0.35
Keira, WS, Crown to Campbell	0.54	0.78	0.78	0.82
" " Crown to Ellen	0.35	0.45	0.47	0.59
Keira, ES, Crown to Campbell	0.65	0.65	0.95	0.98
" " Crown to Ellen	0.14	0.16	0.17	0.22
Atchison ES	0.15	0.15	0.15	0.16
Atchison WS	0	0.01	0.06	0.30
Kenny ES	0	0.08	0.21	0.27
Kenny WS	0	0.06	0.16	0.22
Ellen NS	0.03	0.03	0.03	0.03
Church ES	0.22	0.36	0.36	0.36
Church WS	0.42	0.45	0.45	0.44
Kembla ES	0	0.11	0.16	0.22
Kembla WS	0.10	0.16	0.16	0.20
Corrimal ES	0	0	0	0
Corrimal WS	0.29	0.29	0.29	0.29
Railway Pde.	0	0	0	0
Governors La.	0	0	0	0
Belmore ES	0	0.15	0.15	0.15
Belmore WS	0	0	0	0.02
Young ES	0	0	0	0
Young WS	0	0	0.03	0.07

TABLE 4.3 (cont'd)

Street	1958	1962	1967	1972
Rawson SS	0	0	0	0
Rawson NS	0	0	0	0
Regent ES	0	0	0	0
Regent WS	0	0	0	0
Victoria SS	0.03	0.08	0.08	0.20
Victoria NS	0.09	0.09	0.19	0.32
Market, NS, Keira to West	0.11	0.18	0.42	0.55
Market, SS, Keira to West	0	0	0.10	0.10
Market, NS, Keira to East	0.22	0.62	0.62	0.62
Market, SS, Keira to East	0.04	0.04	0.04	0.07
Queen's Pde ES	0	0	0	0
Queen's Pde WS	0	0	0	0
Burelli NS	0	0.03	0.03	0.20
Burelli SS	0.02	0.02	0.20	0.44
Auburn ES	0.07	0.07	0.30	0.48
Auburn WS	0.12	0.12	0.31	0.36

* The Central Business Height Index. Note that all of the CBII's were equated to one hundred (see text).

Burelli SS, and Kenny Streets where the commercial expansion between 1962 and 1972, and relative to 1962 was 85 percent, 95 percent and 70 percent respectively.[1] In the same period there was also some change in the area west of Keira Street. For example, the commercial area at the west end of Market Street grew by about 33 percent relative to 1962, while in Victoria Street the change was about 34 percent.

4.3 The Study Area and its Emerging Maturity

(i) Locational pattern of land uses in the CBD.

Maps 6, 7 and 8 show the broad patterns of land use in the CBD in 1972 and to aid discussion a series of concentric circles, drawn around the PLV point at 300 feet intervals, has been superimposed on the pattern.[2] In addition, Table 4.4 summarises the distribution pattern by major land use categories. It shows the percentage concentrations of each land use in both Crown and Keira Streets and concentrations in the concentric zone (see Maps 6, 7 and 8).

Downtown shopping areas have been traditionally oriented to comparison goods, to the major Department stores, to specialty high-order retailing[3] and interspersed with convenience-goods, restaurants and the like. With increasing city size there also tends to be quite well-defined, specialised land use areas (entertainment, financial and other 'districts'). In Wollongong the central area obviously shows signs of immaturity;[4]

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1. All streets outside the core contained less than fifty percent commercial development.

2. Information in more detail and for each year was, in fact, mapped. However the large scale necessary for working with the maps (plotting individual land uses) made it impractical to include these maps (thirty nine in all) with the thesis. The high cost of cartographical work and map reduction made it prohibitively expensive to reduce all maps to the size of Maps 2, 3, 4 and 5.

3. See over page.

Footnotes 3 and 4 continued from page 90.

3. The notion of attributing some ordinal rank to retailing activities is perhaps most often associated with the work of Berry (Cf. Berry, B.J.L. and Garrison, W. L. "Recent Developments of Central Place Theory" in Papers and Proceedings of the Regional Science Association, Vol. IV, 1958, other references are provided in the Bibliography - Appendix G) and is widely used in the literature on retail location (Cf. Simmons, J. The Changing Pattern of Retail Location, Department of Geography, Research Paper No. 92, University of Chicago, Chicago, 1964). The conceptualisation is best explained by Berry" (1) From the supply side, different commercial functions have different conditions of entry (thresholds), and thus demand minimum trade areas of different sizes for their support; and (2) on the demand side, consumers spend differing portions of their income on different goods and services, and purchase them with differing degrees of frequency. Low threshold, high frequency functions are found in lower level nucleations ("convenience goods centres"), whereas high threshold, low frequency functions are found in higher-level nucleations serving large trade areas ("shopping goods centres"). (Berry, B.J.L. Commercial Structure and Commercial Blight, Department of Geography, Research Paper No. 85, University of Chicago, Chicago, 1963, p. 21). The higher the minimum required trade area the higher the order (level) of the retail outlet (retailing may be defined to incorporate any activity whereby the sale of a service constitutes its essential object - see p. 117 below). Specialty shops such as leather goods stores, antique dealers and so on ... are higher order activities in that the goods are of a special nature and only appeal to a relatively small proportion of the population (hence 'specialty high order retailing'). In order for the store to be a viable proposition a large population (trade area) is required. (Such shops locate in large commercial clusters, rather than in isolation, for the reasons given in Chapter 5 below).

4. Maturity/immaturity in the CBD is used in a comparative sense only. For example, in the Wollongong CBD one can still find single dwelling residences (see tables 4.3, 4.4 and 4.5). Now, if this could be compared with the CBDs of some of the larger cities, such as Sydney's CBD or New York's Manhatten district, it is unlikely that one would find sites given over to single dwelling residences. As the Wollongong population increases, and new threshold population levels are established, it is likely that all residential activities will be 'pushed out' of the Wollongong CBD. Relative to that time, or relative to larger cities, Wollongong may be thought of as still showing some signs of immaturity. (On the temporal aspect it is conceivable that some future event may arrest all further change in the Wollongong CBD. However, this is an unknown factor. A guide to the future is often best provided by past information and table 4.5 suggests that residential activities are currently being 'pushed out' of the Wollongong CBD. Relative to the time when there may not be any single dwelling residences in the CBD, the Wollongong CBD in a sense, may be considered immature). Further discussion on Wollongong CBD's emerging maturity is provided on pages 101 and 109 below.

TABLE 4.4

1972 PERCENTAGE DISTRIBUTION OF MAJOR LAND USE TYPES IN THE C.B.D.

C.B.D. ZONES[1]

Land Use	Level	Crown	Keira	1	2	3	4	5	6	7
Food	Ground	82	8	12	4	16	16	6	28	18
	First	100	0	0	0	0	100	0	0	0
Merc	G	78	0[2]	14	43	0	28	0	14	0
	F	100	0	0	100	0	0	0	0	0
Appa	G	91	10	21	18	20	23	0	18	2
	F	92	8	25	25	33	8	0	0	8
Furn	G	47	30	9	23	21	17	4	17	9
	F	33	66	0	33	0	0	33	33	0
Auto	G	21	21	0	0	9	21	21	30	21
	F	100	0	0	0	100	0	0	0	0
Othr	G	73	17	12	19	16	22	4	19	9
	F	100	0	33	0	0	33	0	0	33
Whsl	G	18	34	4	6	24	24	22	12	6
	F	80	20	7	40	27	13	7	7	0
Fnce	G	54	33	14	18	23	16	7	18	4
	F	52	27	21	7	41	14	3	14	0
Prfn	G	15	20	0	30	20	0	25	25	0
	F	54	27	12	19	38	12	8	8	4
Csvc1[3]	G	25	9	0	9	34	31	0	0	25
Csvc2	G	24	12	0	12	18	18	18	18	18
	F[4]	40	12	8	12	12	48	12	0	8
Entr	G	49	20	8	10	19	18	14	21	11
	F	72	7	21	10	28	10	7	14	10
Rsdn	G	4	6	0	2	11	41	17	11	17
	F	70	23	7	9	9	23	7	30	14

1 = Figures have been rounded.
2 = At the time of the survey the old Anthony Horderns store was vacant.
3 = Csvc1 - medical.
Csvc2 - other community services.
4 = total community services.

but it is apparent that, even at this scale of city sizes, some of the forces at work at the larger scale still operate.

Table 4.4 suggests the importance of Crown Street as a location for the greater proportion of shops selling apparel, foodstuffs, general merchandise and other retail goods, and offices handling finance, insurance and real estate. Apparel stores are highly concentrated in Crown Street - with 91 percent of all apparel land use at ground level and 92 percent at first floor level. Moreover, this land use was concentrated within the 4 inner CBD zones and most of the remaining apparel land use was in the Piccadilly Centre.

Foodstores were also highly concentrated in Crown Street - 82 percent of all foodstores - though in this case concentration was in the outer zones. General merchandise stores and those defined as other retail stores had a 78 percent and 73 percent concentration respectively in Crown Street. The fourth major land use activity located in Crown and Keira Streets was concerned with finance, insurance and real estate - with 54 percent and 33 percent respectively - though clearly there exists some dispersal of these activities into less central locations.

Two land use activities - entertainment and furniture - had similar proportions along Crown Street (49 percent and 47 percent respectively) and are usually associated with the outer edges of the CBD. In Wollongong 30 percent of furniture and appliance stores are located along Keira Street and the remaining 23 percent of these stores are located in the area to the south of Crown Street.

Extensive sites and low value land are required for auto-oriented, wholesale and administrative-type land uses and each of these activities is clearly relegated to the outer areas of the CBD.[1] About 20 percent of auto-oriented land use is located in Crown Street and the same proportion in Keira Street but in both cases showrooms or lots are located on the edge of the most intensively used areas. Wholesale activities are predominantly concentrated in outer zones and particularly in the area south of Crown Street. In close accord with the rather classic pattern, specialist medical services are concentrated in an off-centre though adjacent location in Market Street - 63 percent - with a secondary concentration near the hospital at the Western end of Crown Street.

Lack of data makes it difficult to gauge the importance of the CBD as a retailing centre. However an indication of its importance may be obtained by comparing the number of retail establishments in the CBD with the number of such establishments in the city as a whole. This may be carried out in an approximate manner for the two years in which the broader information was available - 1956/57[2] and 1968/69.[3] In 1956/57 there were 1,104 retail and service establishments in the Greater Wollongong area compared with 392 on the ground and first floors in the CBD (Table 4.5) which represented 35.5 percent of such establishments (28.3 percent of these were located at ground floor level). In 1968/69 there were 1,932 retailing and service establishments in the Greater Wollongong area compared with 423 such establishments on

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1. See the discussion in Chapter three above and Chapter ten below on this notion of land uses requiring large areas being relegated to the periphery.

2. CBCS Yearbook of N.S.W. Vol. 60, 1969, p. 167.

3. CBCS Economic Censuses: 1968/69 Retail Establishments and Selected Service Establishments, reference No. 11.9, p. 9.

on the ground and first floors in the CBD in 1966/67 (Table 4.5) which represented 21.9 percent of such establishments (18.2 percent of which were located on the ground floor). In both years a relatively large proportion of retail trade appears to have been centred on the CBD. However, at least between 1958 and 1967, there appears to have been a relative decline in the importance of the CBD as a retailing centre.[1]

Residences still exist within the area defined as the CBD, and even along the two major commercial axes, Crown and Keira Streets. In immediately adjacent locations, the trend is towards the establishment of higher density housing. But as a mark of the immaturity of the central area old, blighted residences exist almost cheek-by-jowl with commercial land uses.

(ii) Land use changes 1958-1972

Some of the more important land use changes in the period 1958 to 1972 may be readily described. These changes point to an emerging maturity in the Wollongong CBD, a perceptible step towards the establishment of the CBD as a regional CBD.

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1. The Retail Traders Association would not divilge any information on sales turnover,either by volume or value,so that analysis was limited to numbers of establishments. The conclusion in the text, of course, is based on the limited information available. The definition of retailing, for comparative purposes, is here restricted to the selling of goods and 'selected' services. If the information was available to ascertain relative change on the basis of the definition of retailing adopted on p.117 below a different conclusion could well emerge.

TABLE 4.5

LAND USE CLASSIFICATION AND TOTAL NUMBER OF LAND USE TYPES ON THE GROUND AND FIRST FLOORS IN THE C.B.D.

		TOTAL NUMBER					
		1972[1]		1967[2]		1958[3]	
Land Use	Composition	G[4]	F[5]	G	F	G	F
Food	Food stores, eating and drinking establishments	50	2	72	6	61	3
Merc	General merchandise - department, variety and general stores	7	3	9	6	11	3
Appa	Apparel, accessories - shoes, clothing, materials	56	14	58	11	58	17
Furn	Furniture, home furnishings & appliance dealers	47	2	39	5	30	7
Auto	Automotive sales and service, motorcycle, air craft, and boat dealers	44	1	24	2	33	5
Othr	Other retailing - music, hardware, jewellery, antiques, chemist, camera, pet, florist, newsagent, sports	69	3	76	5	61	15
Whsl	Wholesale, light industry, travel and transport, and storage	49	15	50	20	28	9
Fnce	Real estate, finance, insurance	56	29	50	29	32	25
Prfn	Solicitor, architect, accountant etc., govt. adm.	20	26	26	44	39	41
Csvc	Medical, church, charity, associations, unions	49	25	39	28	30	24
Entr Centr	Entertainment and personal service, e.g. cafes, cinemas, beauty parlours	80	29	73	37	58	30
		527	149	516	193	441	179
Rsdn	Residential - single dwellings and flats	185	43	242	43	289	36
		712	192	758	236	730	215

1. Source = Field Survey.
2. Source = 1966/67 Civic Survey, Wollongong Town Planning Department.
3. Source = 1957/58 Civic Survey, Wollongong Town Planning Department.
4. G - ground floor.
5. F - first floor.

Table 4.5 summarises the land use changes in the period. Ground floor commercial uses increased from 441 to 516 between 1958 and 1967 with increases in food, furniture and applicances, other retailing, wholesaling, finance and real estate, community services and entertainment. The number of apparel stores remained constant and first floor activities increased from 179 to 193. Between 1967 and 1972 the number of ground floor commercial activities increased only marginally from 516 to 527 while the total number of first floor activities actually decreased. Indicative of the growing commercial importance of the central area was the decrease in ground floor uses given over to residence - from 289 in 1958 to 185 in 1972.

Perhaps the most predictable and overdue change was the exit of hotels from the peak value zones and their replacement by retailing activities.[1] The 1958-1972 period saw the closure of 3 hotels - the old Flinders Inn Hotel, diagonally opposite the PLV site on the corner of Crown and Keira Streets, was converted to a women's shopping area with boutiques, hair stylist, jeweller etc.; the Commercial Hotel on the corner of Crown and Church Streets was demolished and replaced by David Jones Department store which was opened about 1966; and the Royal Hotel, on the corner of Crown and Keira Streets directly opposite the PLV site in Crown Street, was closed in 1971 and eventually demolished to make way for the present Abbey-Orchard shopping-office complex.

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1. Hotels in the Wollongong CBD depend primarily on bar trade and bottle (can) sales rather than lodging provision. With the growth of urban Wollongong, Hotels were established in the suburbs thus taking a great deal of custom from the CBD hotels.

Two large shopping centres were opened in the central area during the period - the Piccadilly Centre in 1961 and Woolworth's 'family' shopping centre in Burelli Street about 10 years later. Both centres had off-street parking and both were potentially significant 'attractors' of customer traffic. But the 'fringe' location of Piccadilly Centre, isolated from the eastern end of Crown Street by the rail line and with virtually no pedestrian traffic generators to the west, has limited its popularity and development. The Woolworth's centre on the other hand, has become an extremely important shopping focus. (In a consolidating move the firm closed two of its Crown Street variety stores, though not simultaneously).

There were a number of other major changes. Coles variety store expanded its operations in Crown Street (though the neighbouring building, directly on the PLV site, changed its ground floor land use more than half a dozen times throughout the period!). Anthony Horderns Department store, in Keira Street, finally succumbed and was taken over by Walton's Department store for a very short period before eventually being leased by Norman Ross Discounts. Walton's Department store moved from a site almost opposite the present David Jones building to its present location - occupying the former Woolworth's and Marcus Clarke's buildings. The Rural Bank shopping arcade in lower Crown Street was also opened during the period.

The closure of 3 cinemas - the Savoy in Church Street, the Crown theatre in Keira Street and the Civic theatre in Kembla Street - reflected changing consumer behaviour in the face of the widespread diffusion of television. However, the Regent theatre opened on its present site at the beginning of the period and remains the only cinema in the central area. Not all entertainment land uses vacated the city however. The Ironworkers Building in Crown Street, which was to house retailing, office and entertainment activities, was under construction in 1958 as also was the Worker's Club in Market Street. In Burelli Street Wollongong Leagues Club was extended and renovated during the period, as was the R.S.L. Club in Church Street.

There was considerable change in finance-related activities. There were important new insurance buildings opened during the period - the C.M.L. building in 1965/66 and the New Zealand Victoria Insurance building in Market Street. First class office accommodation came later in the period with the construction of the I.M.B. building (in Crown Street) and Lombard House in Market Street.

Current developments in the central area - the Crown Central complex, the Bank of N.S.W. building, both in Crown Street, and the motel-office complex in Keira Street - will alter present patterns quite dramatically.

(iii) Some features of the property market in central Wollongong.

Activity in the market

As shown by Table 4.6 the sales market in Wollongong was a moderately active one throughout the study period. On average about 5 percent of all properties changed hands each year, although the range varied from a low of about 3 percent in 1964 to 10 percent in 1969. In actual number of transactions this represented 20 sales in 1964 and 67 in 1969. The mean number of sales each year was 33. Four hundred and ninety four properties, representing about 70 percent of all properties, changed hands throughout the period.

TABLE 4.6

PROPERTY TRANSACTIONS

YEAR	Vacant Property Sales			Improved Property Sales			Total Sales		Property transactions as a Proportion of Total Properties
	No.	% of Total	Value $	No.	% of Total	Value $	No.	Value $	
1958	7	24.1	94,580	22	75.9	900,630	29	995,210	4.2
1959	13	31.7	275,916	28	68.3	1,076,700	41	1,352,616	5.9
1960	12	25	207,140	36	75	1,350,454	48	1,557,594	6.9
1961	4	16.7	51,400	20	83.3	674,100	24	725,500	3.5
1962	9	34.6	177,000	17	65.4	1,214,876	26	1,391,876	3.8
1963	8	30.8	131,160	18	69.2	765,176	26	896,336	3.7
1964	8	40	177,700	12	60	518,000	20	695,700	2.9
1965	9	29	591,500	22	71	978,700	31	1,570,200	4.5
1966	4	17.4	45,600	19	82.6	1,148,300	23	1,193,900	3.3
1967	11	47.8	218,900	12	52.2	387,576	23	606,476	3.3
1968	10	35.7	128,210	18	64.3	927,750	28	1,055,960	4.0
1969	29	43.3	854,631	38	56.7	1,983,251	67	2,837,882	9.6
1970	10	23.8	261,000	32	76.2	2,234,300	42	2,495,300	6.0
1971	10	26.3	204,950	28	73.7	1,834,130	38	2,039,080	5.4
1972	8	28.6	436,810	20	71.4	1,406,410	28	1,843,220	4.0
	mean = 30.3%			mean = 69.7%			mean = 33 SD = 12.45		mean = 4.7%

Of the total number of properties which changed hands each year, on an average about 30 percent were vacant allotments. This proportion varied from about 17 percent in 1961 to about 48 percent in 1967.

Ownership status.

The activity in the sales market was accompanied by a remarkable change in the ownership status in Wollongong. This change provided perhaps one of the clearest indications of Wollongong's emerging maturity. Table 4.7 provides information on ownership by type of owner for each year in the study period.[1] The most interesting information is provided by the proportion of properties, in each classification, to total properties. The two outstanding features were the growth in corporate ownership status and the decline in single proprietor ownership status throughout the period. Corporate ownership grew from 26.1 percent of total properties in 1958 to 41.1 percent in 1972. Classifying corporate bodies according to whether they are public or private companies it may be observed that the number of properties owned by publicly listed companies remained relatively stable at around 15 percent throughout the period. On the other hand, the number of properties owned by private companies increased dramatically from 11.6 percent in 1958 to 26 percent in 1972. The decline in the number of properties owned by single proprietors can only be described as violent. The proportion decreased from about 49 percent in 1958 to 29 percent in 1972. Much of the decline in single proprietor ownership can be attributable to the exodus of single dwelling residences from the centre (see Chapter 5) and to the tax and financial advantages which accrue to corporate ownership

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1. Data on the owner and the owner location were obtained for each property each year.

TABLE 4.7

OWNERSHIP STATUS[a]: NUMBER OF PROPERTIES IN EACH CLASS

YEAR	Un-known*	%	Ltd.[1]	%	P/L[2]	%	Partner[3]	%	Prop[4]	%	Public[5]	%	Other	%	Total[7]
1958	2	0.3	101	14.5	81	11.6	108	15.5	340	48.9	37	5.3	27	3.9	696
1959	2	0.3	103	14.8	96	13.8	104	15.0	328	47.3	36	5.2	25	3.6	694
1960	2	0.3	109	15.7	108	15.5	106	15.3	305	43.9	40	5.8	25	3.6	695
1961	2	0.3	108	15.5	120	17.2	105	15.1	295	42.4	41	5.9	25	3.6	696
1962	2	0.3	106	15.5	124	18.1	104	15.2	282	41.1	43	6.3	25	3.6	686
1963	2	0.3	107	15.4	129	18.5	110	15.8	279	40.1	43	6.2	26	3.7	696
1964	2	0.3	110	15.8	131	18.8	107	15.4	275	39.6	44	6.3	26	3.7	695
1965	2	0.3	111	16.0	135	19.4	108	15.5	269	38.7	45	6.5	25	3.6	695
1966	3	0.4	110	15.8	144	20.7	107	15.4	260	37.4	46	6.6	26	3.7	696
1967	4	0.6	105	15.1	150	21.6	103	14.8	262	37.6	44	6.3	27	3.9	695
1968	5	0.7	105	15.1	153	22.0	105	15.1	253	36.4	48	6.9	29	4.2	698
1969	6	0.9	107	15.3	163	23.3	100	14.3	234	33.4	57	8.1	33	4.7	700
1970	5	0.7	105	15.0	169	24.2	100	14.3	225	32.2	60	8.6	34	4.9	698
1971	7	1.0	109	15.6	173	24.7	101	14.4	211	30.1	63	9.0	36	5.1	700
1972	7	1.0	106	15.1	182	26.0	99	14.1	203	29.0	66	9.4	37	5.3	700

1. Public company and wholly owned subsidiary.
2. Private company.
3. Partnership.
4. Single proprietor.

a. Source - Valuer General Valuation Records and Owner Return Files.

5. Federal, state and local government.
6. Other - churches, charitable organisations etc.
7. Total number of properties may alter due to amalgamations and subdivisions - there may also be a random counting error.

especially in the light of redevelopment potential. Other changes in ownership status were less dramatic. There was a very slight but definite decline in partner ownership from 15.5 percent in 1958 to 14.1 percent in 1972. Government ownership almost doubled from 5.3 percent to 9.4 percent. The number of properties owned by church and charitable organisations increased from 3.9 percent to 5.3 percent.

As indicated by Table 4.8 changes in the location (home address) of the owner were less pronounced. As expected by far the majority of property owners had an address as listed in the Wollongong Statistical District. However there was a slight decline in this number throughout the period, from 71.6 percent of total properties in 1958 to 67.4 percent in 1972. The number of properties whose ownership address was listed as Sydney increased from a sizeable 24.5 percent in 1958 to 29 percent in 1972. One would expect that as Wollongong grew, and investment and capital gain opportunities improved, outside bodies would tend to widen their interests in the local community.

Tenancy status.

Throughout the study period the tenancy status was remarkably stable in spite of the ownership and land use changes which had taken place. Table 4.9 indicates that properties which were owner occupied averaged 40.7 percent of total properties each year with a standard deviation of 1.3 percent. Furthermore, an average of 50.1 percent of all properties (SD of 0.73 percent) had tenants each year. An interesting feature of the table is the increase in the number of vacant allotments each year. The primary cause of this was due to the purchase and demolition

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1. Such as the Railway Street project proposed by Howell and Company, Sydney based developers (I.D.M., 13/10/71), but yet to be undertaken.

TABLE 4.8

OWNER LOCATION STATUS[a] (By number):

HEAD OFFICE OF PROPERTY OWNER IN -

YEAR	W.S.D.[1]	%	Sydney[2]	%	O N.S.W.[3]	%	Inter[4]	%	Total
1958	498	71.6	173	24.9	12	1.7	13	1.9	696
1959	497	71.6	175	25.2	12	1.7	10	1.4	694
1960	492	70.8	181	26.0	10	1.4	12	1.7	695
1961	494	71	176	25.3	10	1.4	16	2.3	696
1962	494	72.0	179	26.1	10	15.	3	0.4	686
1963	491	70.5	182	26.1	8	1.1	15	2.2	696
1964	486	69.9	186	26.8	8	1.2	15	2.2	695
1965	481	69.2	193	27.8	8	1.2	13	1.9	695
1966	478	68.7	193	27.7	8	1.1	17	2.4	696
1967	484	69.6	189	27.2	8	1.2	14	2.0	695
1968	483	69.2	189	27.1	8	1.1	18	2.6	698
1969	484	69.1	188	26.9	7	1.0	21	3.0	700
1970	480	68.8	197	28.2	6	0.9	15	2.1	698
1971	472	67.4	204	29.1	6	0.9	18	2.6	700
1972	472	67.4	203	29	7	1.0	18	2.6	700

1. Wollongong Statistical District.
2. Sydney and Suburbs.
3. Other New South Wales locations.
4. Interstate.

a. Source - Valuer General Valuation Records and Owner Return Files.

PROPERTY

YEAR	O.O.[1]	%	O.O. with Tenants[2]	%	Ten.[3]	%	Govt.[4]
1958	284	40.8	51	7.3	305	44.1	0
1959	282	40.6	49	7.1	306	44.1	0
1960	287	41.3	49	7.1	299	43	0
1961	291	41.8	52	7.5	292	42.0	0
1962	292	42.6	49	7.1	284	41.4	0
1963	290	41.7	51	7.3	292	42.0	0
1964	285	41.0	53	7.6	295	42.4	0
1965	285	41.0	52	7.5	298	42.9	0
1966	283	40.7	53	7.6	299	43.0	0
1967	286	41.2	54	7.8	297	42.7	0
1968	291	41.7	54	7.7	292	41.8	0
1969	279	39.9	56	8.0	295	42.1	1
1970	273	39.1	57	8.2	293	42.0	1
1971	269	38.4	54	7.7	295	42.1	1
1972	265	37.9	53	7.6	295	42.1	1

1. Completely owner occupied.
2. Owner occupied with tenants.
3. Completely tenanted.
4. Government (Federal, State, Local leased).
5. Other (churches, charities etc.)
6. Vacant Building.

TABLE 4.9

TENANCY STATUS

%	Other[5]	%	Vac. Bldg.[6]	%	Vac. Land[7]	%	Total
0	3	0.4	2	0.3	51	7.3	696
0	3	0.4	2	0.3	52	7.5	694
0	3	0.4	4	0.6	53	7.6	695
0	3	0.4	4	0.6	54	7.8	696
0	3	0.4	4	0.6	54	7.9	686
0	4	0.6	4	0.6	55	7.9	696
0	4	0.6	4	0.6	54	7.8	695
0	4	0.6	4	0.6	52	7.5	695
0	4	0.6	4	0.6	53	7.6	696
0	4	0.6	3	0.4	51	7.3	695
0	4	0.6	3	0.4	54	7.7	698
0.1	4	0.6	3	0.4	62	9.9	700
0.1	4	0.6	3	0.4	67	9.6	698
0.1	4	0.6	3	0.4	74	10.6	700
0.1	4	0.6	3	0.4	79	11.3	700

7. Vacant land - the increase in vacant lots is largely due to the purchase and demolition of old residential properties by the local government to make way for car parking projects. Another factor was the purchase and demolition of residential properties, by development companies, for redevelopment purposes.

of old residences, on the periphery of the CBD, by local government to make way for carparking projects. A secondary cause was due to the purchase and demolition of old properties by private enterprise to make way for redevelopment projects.[1]

Investment returns

Babcock's rule of thumb in calculating rates of return on real estate properties was utilised to indicate the type of return experienced by investors in the Wollongong CBD property market.[2] In this case the rate of return was measured as the ratio between total net income before taxes, depreciation or financing charges, as a percentage of the total value of the property. In the absence of more precise information this method provides a rough indication of the internal rate of return.[3] The return was calculated for each property in the CBD core.

Table 4.10 lists the results by street block and for the core as a whole. It may be observed that good returns were available on real estate in the CBD core throughout the study period.[4] The mean return

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1. Such as the Railway Street project proposed by Howell and Company, Sydney based developers (I.D.M., 13/10/71), but yet to be undertaken.

2. Babcock, F. M. The Valuation of Real Estate, Macmillan, New York, 1932, p. 440.

3. The internal rate of return may be calculated by the following formula:

$$Po = \sum_{i=1}^{n} Ri/(1+r)^{i} + Pn/(1+r)^{n}$$

where Po = present price, Ri = annual lease payment in period i payable in arrears; Pn = value of reversion in period n; n = the number of periods in the lease; r = internal rate of return (Cf. Wendt, P. F. and Cerf. A. R. Real Estate Investment Analysis and Taxation, McGraw-Hill, New York, 1969, p. 32). However this formulation requires information which was not available to the author. Therefore, Babcock's method, as given above, was utilised.

4. These are returns on the property as such. They give no indication of the return to the business housed by the property.

RETURNS TO PROPERTY OWNER

Street Block	Code	
Crown, NS, Keira to Railway	1	Mean SD
Crown, NS, Keira to Church	2	
Crown, NS, Church to Kembla	3	
Crown, NS, Kembla to Corrimal	4	
Crown, SS, Keira to Railway	5	
Crown, SS, Keira to Church	6	
Crown, SS, Church to Kembla	7	
Crown, SS, Kembla to Corrimal	8	
Keira, WS, Crown to Ellen	9	
Keira, WS, Crown to Market	10	
Keira, WS, Market to Campbell	11	
Keira, ES, Crown to Ellen	12	

TABLE 4.10

- CBD CORE

1958	1962	1967	1972
6.71	9.98	11.92	12.36
1.58	3.40	2.95	1.60
5.49	9.20	11.51	7.86
1.60	1.91	2.88	1.65
5.74	10.05	11.85	11.12
1.20	2.39	2.94	1.91
6.79	10.24	14.68	11.88
1.30	1.32	6.72	3.91
6.83	9.95	11.83	11.39
4.91	1.89	2.12	3.55
5.84	11.26	11.78	10.90
0.65	3.62	2.36	2.52
6.16	7.72	12.76	12.16
0.71	3.69	4.14	4.65
6.68	3.76	12.06	12.15
2.35	2.04	1.81	1.34
7.90	9.42	12.07	9.86
2.48	2.08	2.82	2.05
8.36	9.44	9.49	9.51
1.62	1.29	1.12	0.71
6.99	8.96	11.59	9.69
2.74	2.77	2.20	2.90
7.42	9.81	12.61	11.64
1.35	4.03	1.64	5.51

Street Block	Code	
Keira, ES, Crown to Market	13a	Mean SD
Keira, ES, Market to Campbell	13b	
Crown W, NS. Railway to Darling	14	
Crosn, NS, Corrimal to End	15	
Crown, SS, Corrimal to End	16	
Crown W, SS, Piccadilly to Darling	17	
Aggregate		
Long Term Bond Rate*		

* Source: Reserve Bank Bulletin

TABLE 4.10 (cont'd)

	1958	1962	1967	1972
	6.76	8.08	10.28	-
	2.16	1.47	3.45	-
	8.37	10.37	13.13	13.26
	2.66	1.95	3.54	2.93
	7.74	10.10	10.41	11.71
	2.63	2.37	2.21	2.26
	10.51	12.66	15.72	12.27
	0.61	1.64	3.55	2.44
	-	-	-	-
	6.75	9.80	10.84	12.15
	1.66	3.75	2.47	1.73
	7.18	9.24	11.88	11.25
S_e	1.31	2.02	1.60	1.34
	4.88	4.37	5.11	6.40

increased from 7.18 percent in 1958 to 11.25 percent in 1972.

The return varied from street to street throughout the study area. Utilising Map 1 it may be observed that the peripheral streets such as 14, 15 and 16 usually had much higher returns than the inner streets such as 2, 6, 3 and 7. Note, however, that the mean return in each street each year was above the long term bond rates.

Table 4.11 presents the proportion of property returns which may be attributable to activities located on the ground floor of a property. The table indicates that the Wollongong commercial area was oriented very much towards ground floor activity. Throughout the period approximately 77 percent of property returns were attributable to the ground floor.

4.4 Conclusion

This chapter has achieved two purposes. It has delineated that part of the Wollongong commercial area from which the data for experimental purposes were extracted. This area, in effect, represents the 'core' of the Wollongong CBD. It is the most intensively utilised commercial area in Wollongong. The discussion considered a number of methods of delimitation but finally settled on a techniques similar to that devised by Murphy and Vance. The technique differed from that of Murphy and Vance to the extent that the concept of 'CBD use' was abandoned and hence one index, the CBII, was eliminated (in effect). The chapter also introduced the reader to the study area in terms of land use composition, ownership structure and so on ... The discussion suggested, inter alia, that the Wollongong CBD was relatively immature in the sense that it contained uses which would be unlikely to be able to compete successfully for site area in larger, more developed CBDs (such as Sydney, New York etc.). In a brief discussion on returns to the property investor (the desirability of the Wollongong CBD as an investment medium) it was suggested that, in relation to the long term bond rate, the Wollongong CBD presented a profitable outlet for property investors.

TABLE 4.11

PROPORTION OF PROPERTY RETURNS

ATTRIBUTABLE TO GROUND FLOOR - CBD CORE

Street Block	Code		1958	1962	1967	1972
Crown, NS, Keira to Railway	1	Mean	71.81	73.73	77.72	77.98
		SD	7.64	15.02	14.29	12.61
Crown, NS, Keira to Church	2		93.71	91.75	91.51	93.34
			12.57	13.59	2.88	13.23
Crown, NS, Church to Kembla	3		75.57	76.80	78.93	77.47
			16.83	11.29	10.39	15.89
Crown, NS, Kembla to Corrimal	4		80.58	76.78	74.39	74.23
			14.18	16.84	21.07	17.94
Crown, SS, Keira to Railway	5		75.27	77.13	76.89	76.74
			22.74	21.20	22.50	21.80
Crown, SS, Keira to Church	6		65.21	69.99	68.84	66.81
			13.07	10.89	17.58	16.62
Crown, SS, Church to Kembla	7		72.32	81.79	71.46	72.84
			12.31	18.60	12.89	10.67
Crown, SS, Kembla to Corrimal	8		84.73	98.57	87.90	87.08
			14.21	4.29	14.07	14.09
Keira, WS, Crown to Ellen	9		88.75	82.35	83.81	81.59
			19.87	21.79	22.26	26.08
Keira, WS, Crown to Market	10		52.02	57.23	59.44	60.55
			36.68	32.87	32.15	30.93
Keira, WS, Market to Campbell	11		72.34	73.15	70.54	65.02
			10.73	12.18	12.11	15.48

Street Block	Code	
Keira, ES, Crown to Ellen	12	Mean SD
Keira, ES, Crown to Market	13a	
Keira, ES, Market to Campbell	13b	
Crown W, NS, Railway to Darling	14	
Crown, NS, Corrimal to End	15	
Crown, SS, Corrimal to End	16	
Crown W,SS, Piccadilly to Darling	17	

TABLE 4.11 (cont'd)

	1958	1962	1967	1972
	92.76	90.75	91.75	94.72
	17.25	17.52	16.72	7.47
	95.01	95.01	85.45	88.06
	14.96	14.96	23.68	19.76
	88.43	88.41	87.74	87.77
	16.41	16.43	17.56	19.45
	78.96	79.43	79.44	78.76
	24.29	23.42	23.42	23.69
	79.67	75.60	75.68	77.10
	17.82	21.39	21.28	23.97
	48.31	87.14	48.31	48.30
	-	-	-	-
	79.84	76.87	82.40	81.06
	7.75	8.63	12.92	12.54
	77.52	80.24	77.34	77.19
S_e	12.99	9.93	11.10	11.70

CHAPTER 5

COMPETITION FOR FLOOR SPACE IN THE WOLLONGONG CBD

5.1 Introductory Statement

5.2 The Demand for Floor Space in a Retail Cluster - Consideration of an Abstract Case

(i) Hotelling's thesis

(ii) Utility maximisation, market area expansion and the tendency to cluster.

5.3 Land Use Clusters in Central Wollongong

(i) The street block as a sub-market in the central city property market.

(ii) Land Use structure in Wollongong - land use types which compete directly for available floor space.

(iii) Comparisons between planned and core areas and the change in affiliations through time.

(iv) A competitive hierarchy of land use types.

(v) Variation in the number of land use types as distance from the PLV site varies

5.4 Conclusion

5.1 Introductory Statement

In examining the competition for floor space in the Wollongong CBD the present analysis[1] assumes the existence of the areas of similar locational desire which Chapter three argued exist. Recall that in Chapter three it was demonstrated that, in the Wollongong CBD, there existed a land value variation within small units of analysis which could not be explained by spatial models of land value determination. It was suggested that a reason for this may be that these small areas (for example, a street block) were areas of similar locational desire. By this was meant that a firm would be relatively indifferent to location (with respect to the PLV site) anywhere within the area - despite the fact that on a broad scale, for example on a CBD wide basis, the firm may prefer to locate as near to the PLV site (or block) as possible (in terms of the similar locational area notion this implies that a firm may prefer an area closer to the PLV block rather than further away). A suggested implication of this locational area concept was that, if a firm was indifferent to location anywhere within a particular area, then any land value differences which existed in that area were due to the operation of other (non spatial) forces. These areas of similar locational desire may or may not be represented by a street block - they may be larger or smaller. However it is reasonable to suppose that the street block is a suitable representation as street intersections would tend to be creators of friction to the smooth flow of pedestrian traffic.[2]

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1. And the analyses in later chapters.

2. If the firm is relatively indifferent to location anywhere within this small area, then this supposes that the volume of pedestrian traffic (an indicator of potential sales) is much the same anywhere within the area.

Prior to examining the competition for floor space at this small scale, however, the chapter (Section 5.2) queries the broader problem of why businesses tend to locate in clusters or groups, whether this cluster be a central business district, a regional/suburban business district, or some sub-district within these broader groupings. In other words, what is the basis for the competition for floor space in a business district (i.e. why do firms demand floor space in a group or cluster)? In considering this question the discussion is presented in two parts. On the one hand Hotelling's argument for the tendency of commercial firms to cluster is presented. It is shown, however, that Hotelling's thesis provides a poor explanation for the clustering of firms. The second part of the discussion attempts to present a more plausible case for the tendency of business firms to cluster - Hotelling's assumptions are expanded to present an alternative, and possibly more acceptable, argument. Although the argument appears to be implicit in the literature, it does not appear to have been presented explicitly.

Having established on an abstract plane the basis for the competition for floor space, Section 5.3 turns to the examination of the competition for floor space in the Wollongong CBD. The analysis is presented in five parts. The discussion commences by establishing that some groups of land uses compete consistently for floor space at a street block level throughout the CBD. Part two seeks to isolate those land uses which compete consistently for available floor space in each block (i.e. which land use types appear to consistently locate near each other) and which land use types appear to consistently avoid competing for the available floor space in each block. This analysis considers both the 'planned' CBD area and the 'core' area.

Later discussion examines the extent to which the composition of land use types in small areas (clusters) may differ between the core and planned areas and the change in composition in these areas over time. One conclusion which emerges from this discussion is that there tended to be an increase in area specialisation over the study period, a further indication of Wollongong's emerging maturity.

Discussion in part four inquires as to the competitive hierarchical nature of the land use types. In each street block some land use types may locate consistently on relatively high priced floor space, some on 'one-off' high priced space, and so on ... The analysis attempts to ascertain whether such a statistical relationship exists in Wollongong and to establish the particular hierarchical arrangement. The importance of the discussion rests in its underscoring of the demand for commercial floor space.

The analysis of Section 5.3 is completed with a consideration of the manner in which the number of land use types vary with distance from the PLV site. In effect the analysis examines the variation in spatial demand for floor space by different land use types.

5.2 The Demand for Floor Space in a Retail Cluster - Consideration of an Abstract Case.

(i) Hotelling's thesis

The theoretical problem of whether retailing (defined in the Aubert-Krier sense)[1] firms will locate in an aggregate or dispersed fashion evoked a great deal of controversy among economists particularly in the 1930's-40's. Of the arguments advanced for the tendency of firms to aggregate perhaps the most elegantly simple thesis was that put forward by Harold Hotelling.[2] Hotelling attempted to demonstrate how the competition for market share would result in the inclination of firms selling similar products to aggregate. However his analysis has been shown by a number of authors to be unduly restrictive.

Hotelling commenced his analysis for the specific duopoly case and later extended it for a large number of sellers. His analysis was based on a number of highly simplifying assumptions viz:

- buyers were uniformly distributed along a finite stretch
- transport cost per unit of distance was constant
- no customer had any preference for either seller except on the ground of price plus transport cost
- the cost of production was zero
- demand was perfectly inelastic
- transport costs were borne by the consumer

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1. Namely, that sale of a service constitutes its essential object (Cf. Aubert-Krier, J. "Monopolistic and Imperfect Competition in Retail Trade" in Chamberlin, E. H. (ed.) Monopoly and Competition and Their Regulation, Macmillan and Co. Ltd., New York, 1954, p. 282.

2. Hotelling, H. "Stability in Competition", Economic Journal, Vol. 39, 1929.

- each competitor adjusted his price (location) so that, with the existing value of the other price, his own profit would be a maximum
- each seller was able to supply the entire market alone.

Based on these assumptions Hotelling was able to show that the two firms would locate juxtaposed at the centre of the finite strip. Hotelling then extended his analysis for a large number of sellers "As more and more sellers of the same commodity arise, the tendency is not to become distributed in the socially optimum manner but to cluster unduly".[1]

This thesis has been heavily criticised. Losch objected to Hotelling's argument on the basis of (a) unlikely behaviour of firms and (b) unlikely circumstances.[2] As for (a) he concluded that "Consistently pursued, Hotelling's case leads, under his own assumptions, to the result that it is completely irrelevant for both enterprises where they will locate as long as they are located symmetrically".[3] Losch argued that it was unlikely that one of the competitors would assume that his rival would not react to his own behaviour. If at the outset each vendor was aware of his competitor's likely behaviour then, given the first location, the other duopolist would locate symmetrically at the opposite end of the stretch (thus there would be no need for the public control suggested by Alonso).[4] In fact Palander has shown that if both duopolists act alike there is a pronounced tendency towards

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1. Ibid., p. 53.
2. Losch, A. The Economics of Location, Yale University Press, London, 1964.
3. Ibid., p. 75.
4. Alonso, W. "Location Theory" in Friedman, J. and Alonso, W (ed.) Regional Development and Planning; A Reader, M.I.T. Press, Cambridge, 1964, p. 82.

deglomeration and each vendor would be optimally located one sixth of the length of the stretch from either end.[1]

As regards unlikely circumstances, Losch questioned the assumption of inelastic demand, which he considered to be a rare case. He thought that if this assumption was dispensed with then "... an enterprise will locate exactly at the quarter point if it selects an equilibrium point at all, since every other point lies asymmetrically in the market and thus limits demand and profit possibilities".[2]

The inelasticity assumption has also been questioned by Lerner and Singer who suggested a modification such that demand was inelastic over a price range extending from zero to a finite upper limit.[3] They felt that this was necessary in order to be realistic since "... if interpreted literally (i.e. Hotelling's assumption) it is only possible for each vendor to purchase one unit, irrespective of price, if there is no upper limit to his expenditure. In such a case the location of a single seller is indeterminate, for in any location a unit can be sold at an infinite price".[4] Smithies felt it was necessary to "... go further and assume an elastic demand function at every point of the market".[5] The case of duopolists facing an elastic demand has been

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1. Cf. Smith, D. M. Industrial Location, John Wiley and Sons, New York, 1971, pp. 119-125.

2. Losch, op.cit., p. 74.

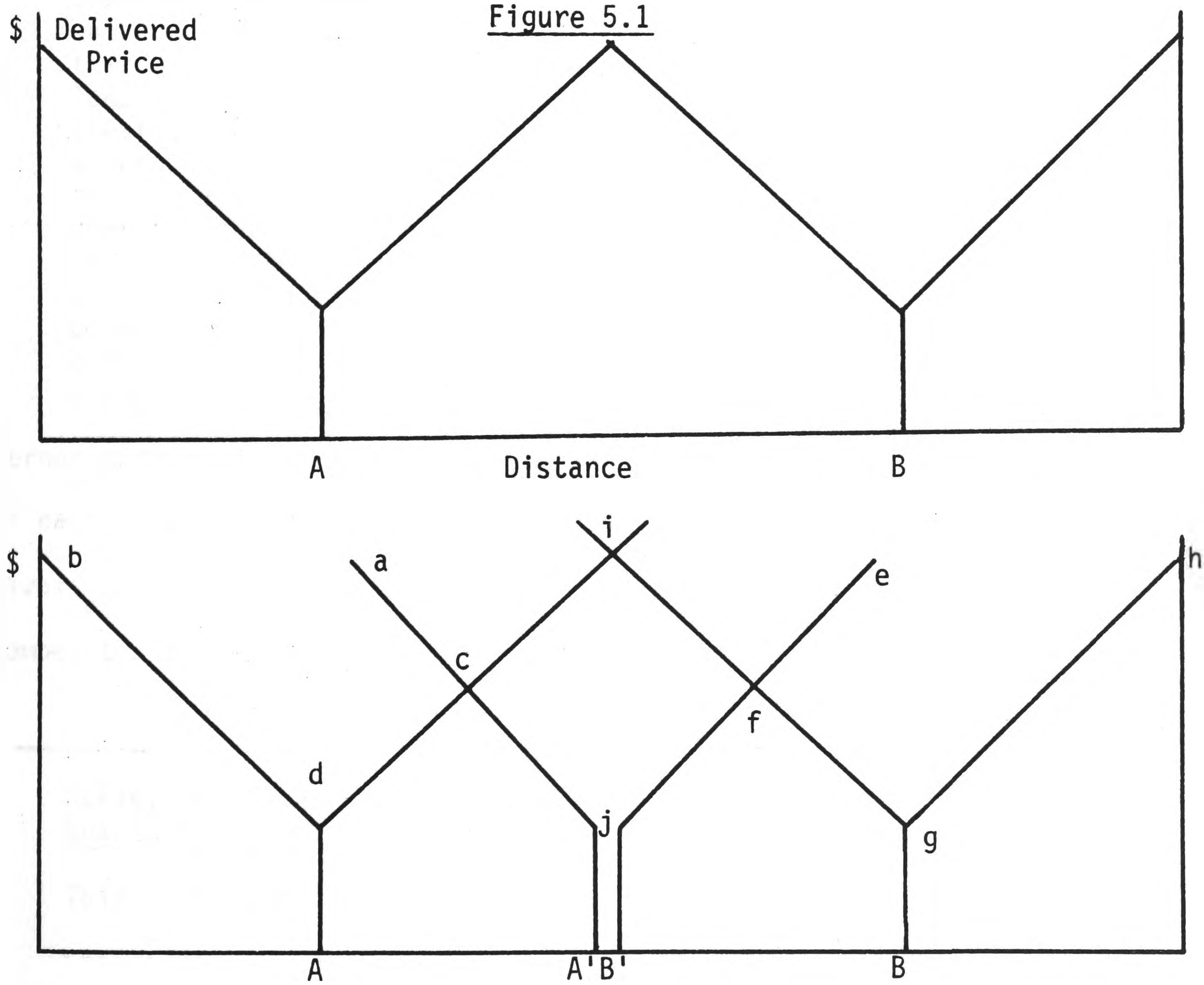
3. Lerner, A. P. and Singer, H. W. "Some Notes on Duopoly and Spatial Competition", Journal of Political Economy, Vol. 45, 1937.

4. Ibid., p. 148.

5. Smithies, A. "Optimum Location in Spatial Competition", Journal of Political Economy, Vol. 49, 1941, p. 424.

considered by Smith who argued that if prices were allowed to effect sales then delivered price at the extremities (where it would be highest) ought to be reduced.[1] If this was not to be accomplished through manipulation of the f.o.b. price he argued then, in a linear market, the quartile locations would be the most advantageous, to either a two plant monopolist or two competing firms. A comparison can be made between this proposition and the Hotellian back-to-back central location (Figure 5.1). In Figure 5.1 (acdb) + (ehgf) > (cifj) where (acdb) + (ehgf) represent the cost saving with quartile locations and (cifj) represents the cost saving with central location.

Figure 5.1



1. Smith, op.cit., p. 141.

Ackley has questioned the assumption of a uniform population density.[1] He noted that the more likely case was the existence of discrete markets. In his conclusions he stated

> ... the discontinuity of the market itself is an important factor in determining what assumptions sellers will make. There is no continuous or inevitable approach to any equilibrium, except as sellers make decisions as to whether to attempt to enter, or whether to withdraw from, or whether to allow the rival to share, any market. These decisions are made, not on the basis of any rigid assumption, but merely on a judgement as to the expected profits from each course.[2]

Chamberlin amongst others, has questioned the extension of Hotelling's case to more than two sellers

> For three sellers, the outcome seems to be that two of them, say A and B, would be located at the quartile points and the third, C, at any point between them. Dispersion would be at least this far for, if we suppose either A or B to move towards the centre in order to enlarge this market, his place would be promptly taken by C. ... Taking the length of line as unity, the general conclusion for n sellers is that the space between the last sellers at either end and the ends of the line can never exceed 1/n (if the number of sellers is odd it can never exceed 1/n + 1), and the space between any two sellers can never exceed 2/n, this limit being reached only in the extreme case where sellers are grouped by twos.[3]

Lerner and Singer have pointed out that, in the case of three competitors, if each competitor acted on the presumption that the location of his rivals were fixed, then there would be complete instability as each competitor attempted to enlarge his market share.[4]

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1. Ackley, G. "Spatial Competition in a Discontinuous Market", Quarterly Journal of Economics, Vol. 56, 1942.

2. Ibid., pp. 228-229.

3. Chamberlin, E. H. The Theory of Monopolistic Competition, Harvard University Press, Cambridge, 1962, p. 261.

4. Lerner and Singer, op.cit.

Losch felt that Hotelling's case might be salvaged for more than two competitors by the abandonment of the line for a small area.[1] However, in a more recent paper, Devletglou has shown that, even in area terms, if some of the implicit economic assumptions are dispensed with, Hotelling's thesis is inapplicable.[2]

(ii) Utility maximisation, market area expansion and the tendency to Cluster.

Although Hotelling argued that a socially optimum condition would be a uniform distribution of sellers in order to minimise real costs to the consumer, he acknowledged that the clustering of sellers existed and he presented an argument attempting to demonstrate why this was so. Hotelling's argument, however, was made far too restrictive by his assumption of only competing goods in the cluster. In the present discussion Hotelling's thesis is extended in an attempt to cope with the fact that the composition of land use clusters is heterogeneous. In so doing it is also demonstrated that the clustering of firms is a socially optimum result (if by this is meant the minimisation of consumer real costs for a given service) and that tangible benefits accrue to both buyer and seller through clustering. Some of the assumptions adopted are similar to those of Hotelling while others have been included to remedy defects which were revealed in the discussion in the previous section. The initial assumptions are:

- a uniform population density in an infinite area
- two sellers marketing non-competing goods

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1. Losch, op.cit.

2. Devletglou, N. E. "A Dissenting View of Duopoly and Spatial Competition", Economica, Vol. 32, 1965.

- transportation costs, t, increase directly with distance, do not vary with load carried, and are borne directly by the consumer[1]
- relatively elastic demand[1]
- zero mobility and production costs for each seller and perfect mobility for both buyer and seller in any direction.
- consumers attempt to maximise utility.

On the basis of these assumptions each seller has a market area similar to that described by the Loshian demand cone.[2]

$$D = b\,\pi \int_0^R f(1+t)\; t\,dt \qquad (5.1)$$

where[3] D = total demand as a function of f.o.b. price 1

b = twice the population of a square in which it costs one unit of money to ship one unit of commodity along one side

π = constant

d = f(1+t) individual demand as a function of price at the place of purchase

1 = price at the place of sale

R = the greatest possible travel costs (LM)

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1. If transport costs weren't borne by the consumer and if demand was relatively inelastic then it would be possible for each seller to practise price discrimination among buyers according to distance, a case which has been discussed by Hoover (1936-7) and Singer (1937-8). (Hoover, E. M. Jr. "Spatial Price Discrimination", Review of Economic Studies, Vol. 4, 1936-37. Singer, H. W. "A Note on Spatial Price Discrimination", Review of Economic Studies, Vol. 5, 1937-38).

2. Losch went on to show that the ultimate ideal shape of the market area would be hexagonal rather than circular. This would be so since circular market areas would present areas of untapped demand as they bordered other market areas. This would be an inducement for new firms to enter the market to tap this demand. The formulation for the market areas is given in Losch, op.cit., p. 106.

3. Cf. Losch, p. 106.

Now, with regard to retailing, suppose utility depends in some manner on the level of prices (l) and the level of transport cost (t) (which may be defined to include the consumer's subjective valuation of his time spent in travelling)[1] i.e.

$$\mu = f\ (l,\ t) \tag{5.2}$$

with $\left(\frac{\partial \mu}{\partial l} < 0,\ \frac{\partial \mu}{\partial t} < 0\right)$

The consumer's real costs are determined by l and t. Since utility decreases with an increase in either of these variables (from 5.2) the converse must also hold. That is, a decrease in real costs will result in an 'outward' movement of the budget constraint enabling the consumer to move to a higher indifferencecurve.

Now, we can make use of the previous assumptions and the above information from the literature to build a more acceptable case for the clustering effect. At the outset let us suppose that two sellers, A and B, are located such that their market area boundaries are tangential. The goods are non-competing and they are both demanded by the consumer. Imagine a consumer, C, located at this tangential point k/2 miles from A or B (i.e. a return journey to either A or B will be K miles). On a weekly (daily...) shopping trip C's total travel costs are 2kt - where t is the cost per mile (if the goods are demanded with the same regularity). The cost (delivered price) of good A is a (f.o.b. price) + kt and the cost of B is b + kt.

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1. Holdren suggestes that the variables are non price offer variation, prices, and distance. (Cf. Holdren, B. R. The Structure of a Retail Market and the Market Behaviour of Retail Units, Prentice-Hall, Inc., Englewood Cliffs, N.J., 1959, p. 118).

Suppose now that both vendors relocate so that they are juxtaposed. C's total travel costs will then be reduced to kt (if we assume that C will make both purchases at the one time) and the cost of good A will be a + kt/2 and B will be b + kt/2. Dispense with the assumption of only two sellers and imagine that there are n non-competing goods (sellers) dispersed throughout the area and located such that C is required to make a return journey (of k miles) to each for his needs.

In that case total costs to the consumer will be $\Sigma k_i t$ (nkt) where Σk_i represents the distance from C to each seller (in summation) in the non cluster situation. The cost of all goods Q_n, will be $q_n + \Sigma k_i t$ (and the cost of any one good will be $q + \frac{\Sigma k_i t}{n}$ i.e. q + kt - assuming a proportionate distribution of travel costs).

Now, suppose that each of these n non-competing goods locate in a cluster which is k miles from C. The cost of all goods, Q_n, will now be $q + \frac{\Sigma k_i t}{n}$ i.e. q_n + kt and the cost of any one good will be reduced to $q + \frac{kt}{n}$. As n tends towards infinity, travel expenses associated with the purchase of any one good (assuming a proportionate distribution of travel costs) will tend towards zero. Thus the actual cost of the good to the consumer will tend towards the f.o.b. price. In essense the tangible benefit to the consumer, C (relative to the non cluster situation, and purchasing n goods) will be [1]

$$\Sigma k_i t - \frac{\Sigma k_i t}{n}$$

$$= kt\ (n-1)$$

---

1. Of course, this benefit will vary according to the distance that would have been travelled if each good in the non cluster situation were not located exactly k miles from C; the extent to which C reduces total travelling by moving from one seller to another (in the non cluster situation) without first returning home; the variation in regularity of purchases etc. But in any case the tangible benefit will be positive.

Since there is a clear decrease in real costs the consumer will move to a higher utility function (the relative movement will differ for each consumer according to his subjective evaluation of his own time).

On the other hand the seller needs to perceive a benefit in order to be enticed to locate in a cluster. Consider seller A in the n - good case. The range of good A will be increased by the difference in costs to the consumer between the purchase of good A as a single item and the purchase of good A amongst n items. In the highly simplified cluster situation discussed above the transport costs of the consumer purchasing good A as a single item were represented by kt. When the purchase of A was one purchase among n items the transport costs for the item were substantially reduced and, assuming a proportionate distribution were represented by $\frac{kt}{n}$. The difference between each of these represents a reduction of the cost of good A to the consumer and maybe expressed as $\frac{kt\ (n-1)}{n}$. Clearly this reduction in cost will extend the market area of the good by either allowing each consumer to purchase more or/and increasing the number of consumers.

The extension of market area may be shown diagrammatically (Figure 5.2). Diagrams (a) and (b) are adapted from Losch.[1]

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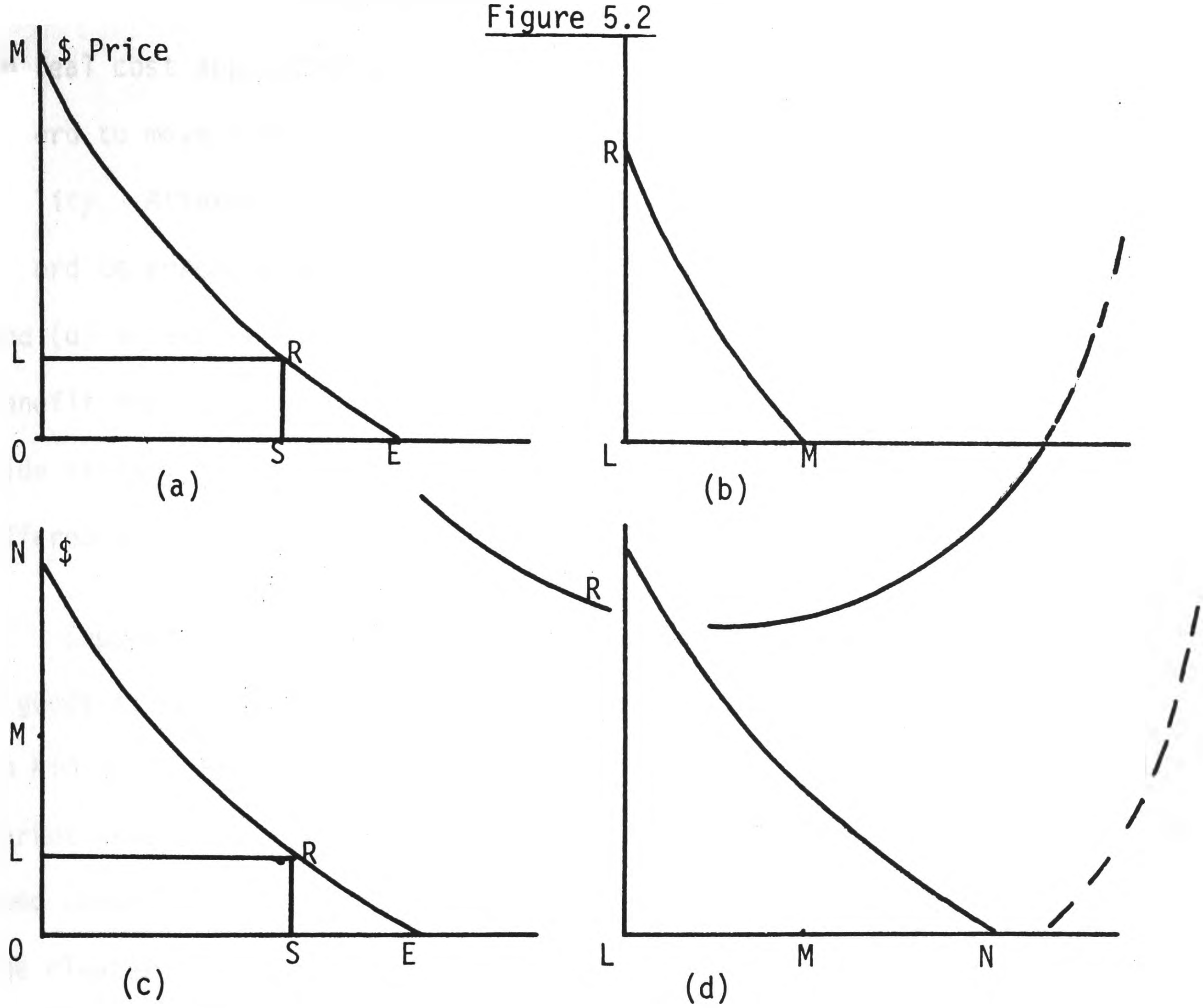
1. Losch, op.cit., p. 106.

Figure 5.2



Losch argued that at the point of sale those buyers who resided in the vicinity of the seller paid OL and received OS. Further away the costs of travelling to the market increased the real cost of the good until some point was reached where the cost of travel equalled LM. At this point the buyer considered the good prohibitively expensive and this delimited the boundary to the seller's market area. Total sales were represented by the volume of the cone resulting from the revolution of LRM on LM as an axis, multiplied by the population density (this was given in equation 5.1 above).

Now, for a consumer purchasing goods in a cluster of n non-competing goods, as the number of purchases increases the real cost of any good, say A, approaches the f.o.b. price a. For those consumers who were located at the margin of prohibitive cost in (a) and (b) the reduction in real cost approaches LM. Thus, the 'marginal' consumer can now afford to move further from the cluster and maintain the same level of utility. Alternatively, consumers further from the cluster can now afford to purchase A, that is, A's market area has increased (Cf. (c) and (d) in Figure 5.2). Non-competing sellers obtain a clear significant benefit from clustering. For instance, since department stores offer a wide variety of commodities the potential market area of all goods offered by the store is increased.

Suppose, now, a seller whose good competes with any of the above n goods is considering a location. The only feasible locations open to him would be (i) in the cluster or (ii) completely outside the market area of the cluster. For example, consider a seller M, whose good competes with A, and who is located in the market area but not the cluster. Assume a customer is located at the midpoint between M and the cluster. Suppose also that the f.o.b. prices of A and M are equal. In the case of one good only being required (A or M) the delivered price will also be the same in each case. However, if the customer requires more than one good his real costs will be smaller if he purchases in the cluster. In this situation M's potential customers will only be those whose straight line path to the cluster will take them past M. On the other hand, other things being equal, if M locates in the cluster he has a 0.5 chance of securing every customer (this argument is far less convencing if M is a convenience good with a high frequency of demand. For instance, suppose in the previous case the distance to the cluster is greater than the distance to M and that M and A are convenience goods and all other goods are shopping goods. In this situation the customer will purchase from M except on those relatively infrequent occasions when a shopping good purchase will be made. Therefore M may have a greater market share than if he located in the cluster).

A perusal of the literature will show that this rather simple argument is supported both theoretically and empirically. In Reilly's 'Law of Retail Gravitation' (1931) for instance "It is obvious ... that the population of a city is an approximate measure only of the 'pull' that the city's shopping facilities may be expected to exert, and distance an approximate measure only of the factors weakening the pull over distance".[1] Chamberlin and Losch have made reference to the attractiveness of a cluster of competing and non-competing goods.[2] Berry, Barnum and Tennant in an analysis of the 'factors affecting distance travelled by rural residents' tested the hypothesis that "... the maximum distance a farmer is willing to travel for any particular central function increases with ... the number of other shopping opportunities that may be satisfied in the centre from which the bulk of the good or service is purchased".[3] Ten regression analyses were completed to evaluate these and other notions and in every case the number of shopping opportunities (central functions) was significant (distance travelled to the centre of first choice being the dependent variable).

Two points may be made of the foregoing discussion:
(i) Hotelling attempted to demonstrate that firms selling similar products would, due to competition for the available market, have a

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1. McClelland, W. G., Costs and Competition in Retailing, Macmillan, London, 1966, p. 204.

2. Chamberlin, op.cit., p. 263. Losch, op.cit., p. 76.

3. Berry, B., Barnum, H. G., and Tennant, R. J. "Retail Location and Consumer Behaviour" in Papers and Proceedings of the Regional Science Association, Vol. 9, 1962, p. 98.

tendency to cluster at the centre of the market. This, he felt, was not a socially optimum result. It was shown that his theoretical argument for the competing good case was insufficient. It was suggested that if the sellers were both competing and non-competing then the economically rational result would be to cluster.[1] It was also suggested that this was a socially optimum result;

(ii) It follows from this that the bundle of goods (sellers) competing directly for floor space in the cluster of activities tends to be a relatively heterogeneous one. That is, it consists of sellers marketing both similar and dissimilar products. The wider the variety of products (assuming each product is demanded with a similar regularity) the larger the potential market area of each seller (and consequently the wider the potential market area of the cluster).

5.3 Land Use Clusters in Central Wollongong

(i) The street block as a sub-market in the central city property market.

It is apparent that clusters of commercial activity exist at all levels: the hamlet is often nothing more than a cluster of commercial activities; every town has its main shopping street; cities have their central business districts, regional and neighbourhood shopping centres

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1. The market area argument has made no reference to the intangible benefits which flow to both buyer and seller from a cluster of commercial activities. For instance the buyer enjoys comparison shopping in terms of quality of goods and both buyer and seller enjoy a more effective realisation of price competition.

and so on ... The existence of each of these may be attributed in come part to the rationale suggested above.[1]

What is not so apparent, however, is that sub-clusters of commercial activity may exist within some of the higher levels - for example in the central business district. It may be recalled from Chapter two that, in general, land uses vie for a location near the PLV site since this is the point of highest potential business. Clearly all such uses cannot simultaneously satisfy that ambition. In what manner may the unsuccessful land use types be expected to locate - in homogeneous groups, in a completely random fashion, or in clusters of heterogeneous land use types? If it can be supposed that roadways are creators of friction to consumer mobility (as distance is a creator of friction to consumer mobility) then the rationale of the previous section may be expected to apply. That is, one would expect clusters of competing and non-competing sellers to exist within street blocks.

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1. The market area argument is only one of many reasons for the tendency of firms to demand a location in a cluster. Alfred Marshall (Marshall, A. Principles of Economics, ed. and annotated by Guillebaud, C. W., Macmillan and Co., London, 1961, Ch. X) presented a systematic treatment of the advantages of the sharing of facilities and the opportunities for specialisation which result from the clustering of firms. Weber (Weber, A. Theory of the Location of Industries, translated by Friedrich, C. J., University of Chicago Press, Chicago, 1929) used the term "agglomeration" to cover three distinct situations one of which related to the economies which resulted from the mere aggregation of manufacturing activities. In a similar vein to Marshall, Vernon (Vernon, R. Metropolis 1985, Harvard University Press, Cambridge, 1960) was at pains to point out that a major reason for clustering in New York was the minimisation of costs through the mutual sharing of facilities (broadly defined to include not only machinery but also knowledge). Goddard, J. B. "Office Communications and Office Location: A Review of Current Research", Journal of Regional Studies, Vol. 5, 1971) demonstrated that the need for face-to-face contact was a major factor influencing the clustering of office activities.

(Of course one would expect that as distance from the PLV site decreased each block would contain groups of higher order activities since these depend on the larger potential market area and are better able to compete for the available floor space.[1] The difference between higher and lower order activities may be one of kind, for example beauty parlours and wholesaling, or one of degree, for example high fashion shops and shops selling 'seconds' or fashion goods which did not capture the market).[2] Since the heterogeneous activities tend to be those which will benefit from mutual proximity location there will be a consistency in the association of land use types.

To test the hypothesis that such groups of commercial activity existed within street blocks in Wollongong, and to discover what these groups were, the 133 different land use types in central Wollongong (the variety of land use types is listed in Table 5.1) were divided into 12 broad land use types (based primarily on the Weiss classification).[3] Using the street block as the basic unit of analysis a correlation co-efficient was obtained for the variation in number of every pair of land use types for the planned and core areas on the ground and first floors

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1. Cf. Chapter four above.

2. Cf. Vernon, op.cit.

3. Weiss, S. F. The Central Business District in Transition, University of North Carolina Press, Chapel Hill, N.C., 1957. There appeared to be something of a generic basis to the Weiss classification and in many ways this is reflected in Table 5.1. For instance the '48 group' is comprised of retail activities, the '9000 group' incorporates entertainment activities and so on ... In order to retain consistency with the ASIC classification (the broad groups such as 3000, 5000 and so on ...) the generic basis broke down in some cases. For instance the '5000 group' ranged from travel agencies to cold stores.

TABLE 5.1

LAND USE VARIETY IN THE C.B.D.

LAND USE CODE BASED ON ASIC CLASSIFICATION

Code 48 group	Land Use[1]
4864	service station
4852	TV service/repair, radio repair
4875	antiques, second hand goods, stamps, coins, pawn shop
4843	mens and boys clothing, mercer tailoring
4826	milk bar, confectionary
4812	variety stores
4844	frocks, hats, womens and girls clothing, babies wear
4854	jewellery and gifts, handicrafts
4823	butcher
4851	sewing machines, radio/tv retail and rental, electrical goods, gas, appliances
4845	shoes
4811	department stores
4871	chemist
4842	fabrics
4872	cameras
4822	delicatessen, groceries, eggs
4846	shoe repairs
4877	bag store, pet store, clothes hire
4828	cake shop
4841	household furniture, floor coverings
4824	fruit shop
4876	florist
4827	fish retailing
4861	motor vehicle spare parts, sales
4825	wines (not for cons. on prem)
4863	tyre sales and retreading
4853	hardware, building supplies
4874	stationary, newsagent, bookshop
4873	sports, ski, bikes, toys
4866	motor cycle sales
4855	record bar, music shop
4821	supermarket

TABLE 5.1 (cont'd)

Code	Land Use[1]
48 group	
4813	general store
4867	hire cars, caravans
4865	panel beaters
47 group	
4719	food wholesaling
4725	chemist wholesaling
4716	soft drinks wholesaling
4724	office supplies
4712	small goods, milk wholesale
46 group	
4664	office machine dealing
4665	refrigerator, air conditioner wholesale, electronic
4666	marine engine wholesale
4672	plumbers fittings wholesale, builders storage, paint, glass
4681	electrical appliance wholesale
4692	womens, girls, infants clothing wholesale
4683	tile wholesaling
4671	timber dealing
4640	fuel oil dealing
4600	unspecified factory
9000 group	
9211	cafe, coffee lounge, catering restaurant
9123	T.A.B. (licensed betting shop)
9116	theatrette
9113	movie theatre
9322	ladies hairdresser, beauty salon
9331	photographic studio
9310	dry cleaning agency, service
9321	barber
9212	hotel, licensed motel
9213	boarding house
9332	funeral parlour
9124	gym, billiard room etc.

TABLE 5.1 (cont'd)

Code	Land Use[1]
9000 group	
9223	leagues, social club
9121	parks, gardens
9224	club, association (unlicensed)
9118	dancing studio, amusement park
8000 group	
8303	church, church ppty, schools etc.
8122	dental surgeon
8124	optometrist
8130	vet.
8421	chamber of commerce
8216	business college
8217	driving school, ballet, tutoring
8302	charitable organisation
8121	GP or other medical - not elsewhere classified
8111	hospital
8212	public school
8125	ambulance service
8421	trade association
8422	trade union
8453	fire fighting service
8127	physiotherapist, chiropodist, chiropractor, orthodontist
7000 group	
7103	local government administration
7102	state government administration
7101	federal government administration
7111	legacy
6000 group	
6351	security service
6112	banking
6121	building society
6122	finance company
6320	real estate operator
6341	solicitor

TABLE 5.1 (cont'd)

Code	Land Use[1]
6000 group	
6331	architect
6223	insurance broker
6342	accountant
6221	medical benefit insurance
6134	stock broker, underwriters
6000	unspecified office type
6348	pest control
6222	loss of profits insurance, loss assessor, motor vehicle insurance, NRMA
6332	surveying service
6310	valuer - real estate
6349	cleaning company
6333	engineer, engineer supplies, town planner
6132	educational trust or foundation
6351	auctioneer
6347	debt collector
6344	advertising
5000 group	
5512	travel agency
5523	storage (office and retail)
5600	post office, telephone service
5522	cold store
5511	transport company
4000 group (not covering 48, 47, 46)	
4219	plaster works
4214	plumbing
3000 group	
3214	motor vehicle brakes
3137	welding and blacksmithing
3000	carwash
3444	signwriting
3213	auto electrical

TABLE 5.1 (cont'd)

Code	Land Use[1]
3000 group	
3112	aluminium windows, screen manufacturer
3136	venetian blind manufacturer
3133	masonary manufacturer
2000 group	
2622	stamps-printing, mfg, exchange, printery
2426	foundation garment mfg, surgical aids
2191	cordial manufacturer
2822	earthenware, construction goods manufacturer
2425	shirt manufacturer
2413	knitted clothing manufacturer
2841	plaster products manufacturer
1000 group	
1234	single dwelling residence
1235	block of flats
1236	residence atop or adjoining
1010	under construction
0000 group	
0000	vacant land
0001	parking
0011	vacant shop or office

Total variety of land uses = 137

1. The land uses refer to those uses which have been given the same ASIC code. This does not necessarily imply that the uses are of a similar nature, or that they exist under the same roof.

for the years 1958, 1967 and 1972.[1] The results are shown in Tables 5.2, 5.3, 5.4, 5.5, 5.6 and 5.7.[2] The tables show quite clearly that clusters of heterogeneous commercial activity existed and that the numbers of individual land use types within the cluster covaried in a consistent manner. Although on a CBD wide scale there may be competition for floor space near the PLV site, the tables suggest that there also exists, as a sub-order, consistent competition between certain land use types for available floor space within the street block. (In fact it will be shown in Chapter 6 that within the street block distance from the PLV site is an insignificant factor in floor space rent determination in most cases).

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1. Whipple used a correlation matrix in seeking land use associations in Melbourne's CBD (Whipple, R.T.M. "Land Use Associations in Melbourne's Central Area", <u>Australian Planning Institute Journal</u>, July, 1968). Similarly, Dunning utilised a correlation matrix in seeking office-type linkages in London (Dunning, J. H. "The City of London", <u>Town Planning Review</u>, Vol. 40-41, 1969-70).

2. The numeral '1' appearing after the land use identification in the various tables refers to the first floor. Also in the tables 'Rent g' refers to the ground floor rental (in each block) and 'Rent 1' refers to the first floor rental. These are being correlated with the number of land use types in each block in order to construct the competitive hierarchy discussed in section 5.3 (iv) below.

TABLE 5.2

1958 PLANNED C.B.D. CORRELATION MATRIX[a]

	Food	Merc	Appa	Furn	Auto	Othr	Whsl	Fncr	Prfn	Csvc	Entr	Rsdn
Merc	.35											
Appa	.72	.54										
Furn	.78	.56	.74									
Auto	.34	.24	.02	.43								
Othr	.91	.60	.04	.78	.25							
Whsl	.19	.07	-.03	.02	.33	.12						
Fnce	.85	.15	.73	.75	.19	.70	.16					
Prfn	.46	.10	.15	.39	.23	.41	.42	.43				
Csvc	.02	-.27	.04	.03	-.19	-.06	-.20	.21	.08			
Entr	.77	.33	.61	.58	.38	.83	.24	.49	.41	-.13		
Rsdn	-.44	-.03	-.40	-.31	.01	-.39	.01	-.37	-.23	-.19	-.46	
Foodl	.50	-.17	.35	.40	.01	.39	.44	.60	.49	.11	.50	-.33
Mercl	.61	.63	.68	.47	.12	.80	-.07	.37	.29	-.19	.57	-.25
Appal	.79	.55	.86	.71	.15	.90	-.02	.70	.42	-.05	.64	-.37
Furnl	.85	.18	.73	.57	.15	.78	.10	.85	.27	.11	.56	-.31
Autol	-.02	.38	-.09	.22	.46	-.02	.29	-.02	.21	-.14	-.07	.19
Othrl	.77	.55	.88	.74	.24	.92	.05	.60	.33	-.09	.85	-.44
Whsll	.71	.15	.81	.62	.03	.66	.05	.87	.70	.22	.45	-.31
Fncel	.72	.19	.65	.65	.05	.69	.22	.81	.69	.06	.50	-.38
Prfnl	.79	.20	.80	.79	.14	.73	.09	.92	.50	.17	.54	-.42
Csvcl	.48	.13	.45	.31	-.06	.47	.17	.55	.55	.40	.30	-.37
Entrl	.63	.58	.93	.70	-.06	.83	.04	.59	.29	-.06	.65	-.43
Rsdnl	.68	.18	.36	.68	.49	.51	-.08	.57	.10	.13	.49	-.30
Rentg	.53	.30	.50	.53	.20	.57	.04	.37	.43	.24	.57	-.51

	Foodl	Mercl	Appal	Furnl	Autol	Othrl	Whsll	Fncel	Prfnl	Csvcl	Fntrl	Rsdnl
Mercl	-.10											
Appal	.22	.90										
Furnl	.47	.58	.74									
Autol	-.08	-.06	-.08	-.07								
Othrl	.33	.79	.89	.64	-.10							
Whsll	.57	.35	.62	.90	-.07	.59						
Fncel	.69	.48	.76	.68	-.09	.61	.64					
Prfnl	.65	.44	.78	.75	-.10	.71	.81	.92				
Csvcl	.25	.46	.55	.58	-.10	.42	.47	.51	.49			
Entrl	.45	.67	.83	.58	-.10	.88	.65	.71	.76	.41		
Rsdnl	.21	.16	.34	.37	-.10	.46	.38	.25	.48	.13	.23	
Rentl	.19	.21	.28	.30	-.05	.38	.26	.19	.30	.34	.23	.44

a = 10% level of significance 0.33

TABLE 5.3

1967 PALNNED C.B.D. CORRELATION MATRIX[a]

	Food	Merc	Appa	Furn	Auto	Othr	Whsl	Fnce	Prfn	Csvc	Entr	Rsdn
Merc	.50											
Appa	.72	.67										
Furn	.66	.32	.65									
Auto	-.29	-.20	-.30	-.06								
Othr	.92	.50	.78	.75	-.21							
Whsl	-.10	-.20	-.20	.00	.14	-.12						
Fnce	.75	.37	.58	.80	-.23	.70	-.09					
Prfn	-.20	-.13	-.18	-.17	.05	-.09	.34	-.17				
Csvc	-.02	-.23	-.21	.01	-.13	-.08	-.11	.17	.24			
Entr	.88	.48	.66	.77	-.21	.88	-.15	.77	-.12	.03		
Rsdn	-.55	-.37	-.48	-.27	.24	-.50	.23	-.48	-.05	-.25	-.51	
Foodl	.20	.76	.48	-.01	-.16	.08	-.10	.01	-.14	-.14	.06	-.20
Mercl	.49	.95	.63	.35	-.13	.55	-.21	.35	-.09	-.20	.52	-.29
Appal	.60	.40	.83	.74	-.19	.79	-.25	.55	-.15	-.17	.65	-.34
Furnl	.56	.30	.69	.80	-.08	.77	-.04	.54	.02	-.18	.62	-.22
Autol	.49	.55	.39	.54	-.02	.67	-.19	.48	.01	-.14	.66	-.20
Othrl	.28	.73	.63	.01	-.19	.19	-.13	.09	-.17	-.15	.13	-.25
Whsll	.69	.42	.87	.80	-.19	.85	-.16	.66	-.13	-.13	.68	-.37
Fncel	.33	.35	.53	.40	.01	.39	.16	.36	-.29	-.17	.27	-.22
Prfnl	.47	.23	.43	.60	-.22	.39	-.08	.82	-.20	.19	.39	-.40
Csvcl	.30	-.11	.15	.13	-.19	.34	-.07	.15	.40	.61	.23	-.42
Entrl	.89	.59	.87	.62	-.33	.92	-.16	.66	-.16	-.16	.81	-.54
Rsdnl	.56	.18	.14	.47	-.01	.38	-.07	.63	-.22	.45	.58	-.30
Rentg	.67	.73	.83	.49	-.30	.66	-.32	.52	-.11	-.09	.57	-.54

	Foodl	Mercl	Appal	Furnl	Autol	Othrl	Whsll	Fncel	Prfnl	Csvcl	Entrl	Rsdnl
Mercl	.69											
Appal	.09	.49										
Furnl	-.07	.42	.90									
Autol	-.04	.69	.59	.65								
Othrl	.97	.66	.28	.09	-.05							
Whsll	.13	.49	.97	.92	.55	.31						
Fncel	.31	.32	.46	.35	.13	.41	.51					
Prfnl	.13	.14	.34	.31	.68	.22	.49	.42				
Csvcl	-.11	-.09	.17	.14	-.02	-.04	.23	.04	.18			
Entrl	.33	.60	.77	.66	.51	.44	.83	.45	.48	.28		
Rsdnl	.08	.21	.09	.08	.21	.07	.17	.12	.43	.16	.26	
Rentl	.15	.12	.22	.19	.02	.21	.27	.36	.41	-.07	.27	-.10

a = 10% level of significance 0.33

TABLE 5.4

1972 PLANNED C.B.D. CORRELATION MATRIX[a]

	Food	Merc	Appa	Furn	Auto	Othr	Whsl	Fnce	Prfn	Csvc	Entr	Rsdn
Merc	.37											
Appa	.70	.40										
Furn	.52	.28	.58									
Auto	-.11	-.17	-.26	-.01								
Othr	.85	.45	.52	.62	-.12							
Whsl	.28	-.03	-.01	.25	.35	.26						
Fnce	.51	.28	.41	.74	-.12	.75	.08					
Prfn	-.27	-.10	-.17	-.07	-.02	-.19	-.01	-.10				
Csvc	-.19	-.22	-.24	-.01	.03	-.09	-.27	.21	-.20			
Entr	.78	.47	.50	.60	-.16	.87	.19	.78	-.25	.08		
Rsdn	-.41	-.31	-.37	-.27	.06	-.37	.14	-.28	.14	-.15	-.45	
Foodl	-.15	-.09	-.09	-.17	.50	-.13	-.08	-.13	-.12	.06	-.13	-.17
Mercl	.40	.44	.45	.08	-.25	.14	.13	.10	-.01	-.21	.19	-.23
Appal	.53	.44	.91	.53	-.20	.41	-.12	.31	-.19	-.19	.33	-.33
Furnl	-.21	-.12	-.04	.31	-.18	-.09	-.11	.18	.07	.09	-.11	.13
Autol	.44	-.09	.75	.51	-.07	.29	-.08	.26	-.12	-.07	.35	-.17
Othrl	.57	.58	.26	.43	-.14	.76	.17	.57	-.09	-.21	.62	-.23
Whsll	.62	.35	.83	.54	.03	.49	.26	.24	-.12	-.28	.34	-.22
Fncel	.43	.16	.60	.68	-.07	.57	.08	.76	-.11	.10	.59	-.32
Prfnl	.55	.26	.60	.68	-.12	.70	.11	.81	-.12	.07	.68	-.34
Csvcl	.26	-.06	.26	.16	-.21	.22	-.17	.19	-.12	.43	.34	-.36
Entrl	.83	.62	.72	.50	-.27	.85	.05	.50	-.15	-.34	.76	-.42
Rsdnl	.64	.18	.29	.35	-.01	.70	.10	.68	-.33	.37	.75	-.40
Rentg	.59	.66	.81	.49	-.24	.52	-.17	.49	-.21	-.03	.53	-.48

	Foodl	Mercl	Appal	Furnl	Autol	Othrl	Whsll	Fncel	Prfnl	Csvcl	Entrl	Rsdnl
Mercl	-.06											
Appal	-.08	.22										
Furnl	-.06	-.08	-.01									
Autol	-.04	-.06	.65	-.06								
Othrl	-.06	.35	.16	-.08	-.06							
Whsll	-.09	.15	.86	-.13	.66	.15						
Fncel	-.10	-.06	.58	-.02	.61	.27	.53					
Prfnl	-.14	-.07	.60	.09	.52	.29	.57	.84				
Csvcl	-.11	-.05	.20	.00	.33	.10	.17	.23	.26			
Entrl	-.12	.22	.66	-.09	.41	.60	.65	.48	.62	.23		
Rsdnl	-.05	.06	.21	-.13	.00	.30	.23	.44	.57	.22	.50	
Rentl	-.04	.04	.55	-.03	.40	.47	.39	.71	.79	.35	.65	.57

a = 10% level of significance 0.33. Note, in all matrices all coefficients were taken to seven decimal places so that unique ranks were assigned to each use.

TABLE 5.5

1958 C.B.D. CORE CORRELATION MATRIX[a]

	Food	Merc	Appa	Furn	Auto	Othr	Whsl	Fnce	Prfn	Csvc	Entr	Rsdn
Merc	.06											
Appa	.57	.42										
Furn	.59	.44	.65									
Auto	.18	.03	-.24	.30								
Othr	.84	.49	.78	.65	.03							
Whsl	.06	-.23	-.24	-.26	.04	-.06						
Fnce	.80	-.13	.63	.66	.04	.56	.03					
Prfn	.31	-.08	-.08	.23	.31	.25	.46	.26				
Csvc	.12	-.49	.13	.27	-.10	-.15	-.43	.46	-.15			
Entr	.63	.10	.46	.30	.23	.74	.26	.27	.26	-.31		
Rsdn	-.39	.35	-.45	-.01	.27	-.36	-.01	-.39	-.52	-.03	-.56	
Foodl	.31	-.45	.18	.17	-.18	.18	.53	.50	.43	.27	.35	-.38
Mercl	.58	.60	.64	.38	.21	.83	-.21	.26	.21	-.37	.52	-.28
Appal	.73	.45	.82	.64	-.01	.89	-.20	.60	.33	-.08	.53	-.43
Furnl	.88	.02	.67	.47	.03	.75	.02	.83	.16	.26	.47	-.34
Autol	-.27	.34	-.26	.09	.51	-.23	.35	-.17	.15	-.26	-.28	.77
Othrl	.64	.42	.83	.61	.07	.89	-.14	.43	.16	-.16	.81	-.54
Whsll	.68	-.02	.76	.56	-.13	.59	-.05	.86	-.06	.48	.30	-.35
Fncel	.62	-.02	.53	.53	-.16	.58	.18	.76	.69	.16	.32	-.45
Prfnl	.68	-.05	.71	.73	-.07	.60	-.06	.90	.42	.44	.33	-.48
Csvcl	.88	.15	.70	.55	-.02	.84	.03	.81	.43	.10	.50	-.41
Entrl	.44	.49	.91	.60	-.32	.78	-.09	.45	.14	-.08	.53	-.47
Rsdnl	.49	-.08	.11	.53	.46	.25	-.35	.30	-.16	.34	.25	-.14
Rentg	.21	.08	.36	.21	-.21	.37	-.35	.03	.18	.30	.27	-.14

	Foodl	Mercl	Appal	Furnl	Autol	Othrl	Whsll	Fncel	Prfnl	Csvcl	Entrl	Rsdnl
Mercl	-.27											
Appal	.34	.90										
Furnl	.37	.52	.69									
Autol	-.19	-.15	-.22	-.18								
Othrl	.12	.78	.86	.55	-.29							
Whsll	.49	.26	.54	.88	-.18	.49						
Fncel	.61	.39	.69	.61	-.23	.47	.56					
Prfnl	.56	.34	.71	.70	-.27	.58	.77	.90				
Csvcl	.34	.71	.88	.91	-.21	.67	.73	.81	.79			
Entrl	.30	.63	.79	.48	-.27	.84	.58	.62	.69	.63		
Rsdnl	-.03	-.02	.11	.21	-.28	.22	.21	-.01	.25	.11	-.07	
Rentl	-.08	.13	.12	.30	-.43	.29	.18	-.15	.07	.15	-.12	.48

a = 10% level of significance 0.33

TABLE 5.6

1967 C.B.D. CORE CORRELATION MATRIX[a]

	Food	Merc	Appa	Furn	Auto	Othr	Whsl	Fnce	Prfn	Csvc	Entr	Rsdn
Merc	.32											
Appa	.58	.59										
Furn	.46	.11	.50									
Auto	-.52	-.36	-.62	-.01								
Othr	.90	.33	.67	.64	-.39							
Whsl	-.21	-.38	-.39	-.27	.32	-.31						
Fnce	.58	.17	.38	.73	-.31	.53	-.25					
Prfn	.01	-.07	-.16	.02	.26	.06	.80	-.17				
Csvc	-.10	-.47	-.48	.07	.40	-.29	-.12	.25	-.46			
Entr	.87	.36	.53	.67	-.22	.88	-.32	.67	-.01	-.01		
Rsdn	-.50	-.40	-.54	-.08	.60	-.43	.48	-.43	.56	.11	-.46	
Foodl	.04	.75	.44	-.26	-.31	-.08	-.18	-.18	-.19	-.26	-.10	-.20
Mercl	.39	.95	.57	.22	-.18	.46	-.38	.20	-.02	-.39	.47	-.31
Appal	.55	.31	.83	.78	-.26	.80	-.40	.49	-.09	-.30	.64	-.34
Furnl	.43	.17	.62	.81	-.01	.73	-.07	.42	.30	-.37	.56	-.02
Autol	.49	.52	.33	.55	-.07	.70	-.32	.44	.16	-.26	.73	-.20
Othrl	.11	.70	.59	-.12	-.39	.02	-.23	-.11	-.24	-.29	-.05	-.25
Whsll	.59	.28	.83	.78	-.31	.81	-.31	.54	-.04	-.30	.61	-.33
Fncel	.42	.47	.83	.51	-.59	.49	-.42	.51	-.36	-.22	.30	-.50
Prfnl	.17	.03	.22	.42	-.37	.10	-.16	.75	-.31	-.27	.08	-.27
Csvcl	.60	-.31	.19	.23	-.32	.55	-.10	.18	-.16	.16	.36	-.26
Entrl	.87	.48	.83	.43	-.65	.89	-.30	.48	-.07	-.40	.70	-.60
Rsdnl	.30	-.06	-.21	.25	.28	.06	-.14	.48	-.30	.84	.43	-.07
Rentg	.43	.74	.82	.25	-.63	.47	-.51	.24	-.33	-.40	.26	-.47

	Foodl	Mercl	Appal	Furnl	Autol	Othrl	Whsll	Fncel	Prfnl	Csvcl	Entrl	Rsdnl
Mercl	.67											
Appal	.02	.43										
Furnl	-.18	.33	.90									
Autol	-.10	.67	.57	.62								
Othrl	.97	.63	.20	-.03	-.42							
Whsll	.02	.40	.98	.91	.52	.21						
Fncel	.45	.44	.71	.48	.14	.61	.77					
Prfnl	.01	-.04	.22	.13	-.06	.09	.33	.65				
Csvcl	-.27	-.26	.29	.18	-.08	-.15	.35	.27	.16			
Entrl	.25	.54	.76	.59	.48	.37	.80	.71	.24	.50		
Rsdnl	-.05	.43	-.11	-.18	.11	-.10	-.11	-.10	.23	.12	-.06	
Rentl	.25	.16	.39	.31	-.03	.36	.47	.79	.70	.12	.33	-.42

a = 10% level of significance 0.42

TABLE 5.7

1972 C.B.D. CORE CORRELATION MATRIX[a]

	Food	Merc	Appa	Furn	Auto	Othr	Whsl	Fnce	Prfn	Csvc	Entr	Rsdn
Merc	.40											
Appa	.57	.42										
Furn	.22	.14	.45									
Auto	-.47	-.47	-.57	-.35								
Othr	.78	.48	.31	.44	-.41							
Whsl	.18	-.03	-.20	-.05	.36	.17						
Fnce	.20	.20	.16	.66	-.48	.62	-.09					
Prfn	-.31	-.19	-.20	.32	.09	-.29	.46	-.07				
Csvc	-.46	-.44	-.43	-.04	.19	-.27	-.32	.29	-.27			
Entr	.73	.30	.35	.43	-.53	.90	-.01	.77	-.39	.01		
Rsdn	-.20	-.28	-.37	.07	.61	-.21	.62	-.27	.46	.17	-.35	
Foodl	-.45	-.18	-.25	-.42	.59	-.35	-.17	-.34	-.18	-.01	-.34	-.15
Mercl	.27	.50	.35	-.15	-.44	-.06	.07	-.11	.12	-.34	.03	-.21
Appal	.34	.48	.89	.41	-.45	.20	-.34	.06	-.27	-.34	.13	-.32
Furnl	-.45	-.18	-.10	.41	-.31	-.23	-.28	.24	.62	-.01	-.20	-.15
Autol	.41	-.18	.75	.53	-.16	.20	-.17	.16	-.18	-.13	.31	-.15
Othrl	.52	.69	.12	.35	-.30	.77	.12	.50	-.07	-.34	.63	-.21
Whsll	.46	.34	.78	.40	-.13	.28	.20	-.07	-.05	-.49	.11	.12
Fncel	.27	.12	.55	.62	-.34	.49	-.09	.75	-.28	.12	.61	-.31
Prfnl	.27	.10	.45	.58	-.43	.53	-.03	.73	-.16	.02	.58	-.33
Csvcl	.56	-.09	.58	.60	-.51	.54	-.19	.48	-.09	-.26	.62	-.45
Entrl	.82	.61	.65	.34	-.58	.83	-.04	.31	-.32	-.58	.69	-.42
Rsdnl	.34	.05	-.08	-.04	-.28	.53	-.08	.50	-.56	.49	.67	-.09
Rentg	.32	.59	.80	.33	-.65	.28	-.36	.24	-.32	-.25	.25	-.45

	Foodl	Mercl	Appal	Furnl	Autol	Othrl	Whsll	Fncel	Prfnl	Csvcl	Entrl	Rsdnl
Mercl	-.14											
Appal	-.22	.09										
Furnl	-.10	-.14	-.05									
Autol	-.10	-.14	.63	-.10								
Othrl	-.14	.28	.01	-.14	-.14							
Whsll	-.24	-.01	.82	-.24	.65	-.08						
Fncel	-.24	-.23	.53	-.02	.63	.17	.44					
Prfnl	-.36	-.34	.47	.16	.50	.14	.41	.93				
Csvcl	-.31	-.19	.43	.22	.75	.18	.36	.64	.70			
Entrl	-.28	.09	.58	-.15	.36	.56	.56	.41	.48	.60		
Rsdnl	-.29	-.20	-.13	-.29	-.08	.14	-.15	.29	.32	.11	.30	
Rentl	-.22	-.17	.50	-.02	.41	.45	.22	.85	.82	.63	.57	.40

a = 10% level of significance 0.42

(ii) Land use structure in Wollongong - Land use types which compete directly for available floor space.

A significant positive correlation coefficient implies that there is a significant direct covariation in the numbers of the pair of land uses concerned. Since the numbers of each land use type increase or decrease together, as between blocks, this suggests that the pair of land uses will always be in direct competition for available floor space.[1] The significant positive correlations in each matrix, then, present a picture of the land use types which derive some benefit from mutual proximity location and which therefore compete directly and consistently for available floor space.

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1. However there are rigidities (Cf. Ch. 2 above) in the property market which hinder the smooth transfer of floor space between one land use and another. The lease period is one such rigidity (Cf. Turvey, op.cit., p. 26). Another is related directly to the difference in land use type - the greater this difference the greater will be the degree of friction involved in converting floor space from one land use type to another. Hence the greater will be the difference in rental required before the space will be converted. Practically any space can be converted for alternative uses. In Wollongong, for example, single dwelling houses have been converted to shops and offices, banking premises have been converted to automobile showrooms, automobile showrooms have been converted to appliance shops and restaurants, a cinema has been converted to a restaurant and so on ... The conversion of floor space from one use to another is known as filtering. The climax in this land use filtering process occurs when broad categories of similar land use types are successful competitors in a particular area and specialised districts, for example financial districts, evolve (by this stage filtering has usually given way to succession i.e. redevelopment). Such districts are composed of land use types which derive a significantly greater benefit from location there than in any other area, and which is greater also than the benefit which other land use types would derive from location in that area.

The 'planned CBD'.

Each of the correlation matrices presents a useful summary - Table 5.4 for example, indicates that in 1972 there were 20 significant positive correlations, 5 significant negative correlations and 41 random associations amongst the 66 pairs of ground floor land use types. Food stores (primarily eating and drinking places) were significantly positively correlated with 6 other land use types - general merchandising, apparel, furniture, other retail stores, financial services and entertainment and personal service centres. One would suspect food stores of being secondary traffic generators whose net returns would be increased by location near any of these land use types. There was a significant negative correlation between food stores and residential land uses. This is to be expected since food stores tend to locate on expensive land in the vicinity of the primary traffic generators. The random associations between food stores and automative, wholesaling, professional, and community service land use types indicate that these land uses may or may not compete with food stores for available floor space. The negative signs of the coefficient between food and automative, professional and community service land use types do indicate, however, that there may be some degree of dissociation between food stores and these land use types.[1]

Clusters of mutually compatible land use types can be obtained from Table 5.4. Of 20 significant linkages on the ground floor, 19 related to the group of 7 land use types itemised above. These land use types showed significant covariation in numbers of activities in

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1. Although the signs are negative the coefficients are not significant.

each block in the CBD. Similar analysis for the negative coefficients showed that all of the significant dissociations related to one land use type, residential. In other words, residential activities on the one hand and entertainment and personal service, food, apparel, other retailing and financial activities on the other, were unlikely to compete for floor space in the same block.

It may be expected that some secondary land use types which are unable to compete successfully for ground level floor space near primary traffic generators may opt for a second best first floor location. Ground floor/first floor affiliations are also shown in Table 5.4. Here it may be observed that 53 of the 144 pairs of ground floor/first floor land use types were significantly linked. Rank tables were constructed for these affiliations and it was found that most of the first floor land use types were linked in some manner with ground floor activities. Seven of the land use types - apparel, wholesaling, entertainment and personal service, other retailing, finance, professional and residential activities - had 6 or more links with ground floor land use types. One particular feature of the affiliations was the attraction between residential and wholesale activities on the first floor and those land use activities on the ground floor (such as food, apparel and general merchandi sing) which are usually found on relatively high priced land. This suggested a degree of immaturity in the Wollongong CBD. There was a significant dissociation between residential activities on the first floor and residential activities on the ground floor. In light of the ground floor affiliations this suggest s that first floor residential activities were able to compete successfully for floor space near the ground floor primary traffic generators. Ground floor residential activities were not similarly successful.

First floor affiliations may arise because of a desire to locate near particular ground floor activities, or perhaps because of the desire of some firms to locate near potential business associates, irrespective of their vertical location.[1] In any case it is unlikely that the reasons for first floor affiliations are similar to the suggested reasons for ground floor affiliations. Irrespective of the reasons the fact that such affiliations exist suggests that there are certain land use types which compete consistently for floor space at the first floor level. Again, Table 5.4 shows the competitive group at the first floor level in 1972. It may be seen that entertainment and personal service, apparel, wholesaling, etc., professional residential and finance activities each competed consistently with more than 3 other land use types (amongst the group mentioned) for available floor space.

(iii) Comparisons between planned and core areas and the change in affiliations through time.

As argued in section 5.2 clusters of sellers may arise due to the benefit to be gained from such aggregation. If the gain to be enjoyed should alter then the composition of the cluster may also alter. The core is the area of most intense commercial activity in the city and, as such, is the area of highest floor space cost (to the tenant). The difference in the cost of floor space between the core and peripheral areas may be sufficient to alter the structure and composition of the clusters which exist in the core and the broader planned area.

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1. Goddard, op.cit., found that the desire for face-to-face contact in making business deals was suggested as a strong reason by management to locate near certain other office type activities.

Correlation matrices for the more compact core area are shown in Tables 5.5, 5.6 and 5.7. In comparing the affiliation structure between the planned and core areas there are three major points on which the structures may differ - the number of significant linkages, the land use types entering the affiliations, and the rankings of the linkage coefficients. One would expect the structures to differ on all three counts if the cost of floor space differs markedly between core and planned areas. The cheaper floor space on the fringes of the CBD tends to reduce cost barriers, which exist in the core, for mutually compatible land use types to locate near each other. Thus, as the cost barriers are reduced positive net benefits through mutual association may again exist (i.e. assuming they exist in the absence of the cost barriers) thereby creating an environment where the number of links amongst existing land use types may increase and/or new links may be forged.

From Tables 5.4 and 5.6 it may be observed that in 1972 there were 8 fewer land use affiliations in the core than the planned area at the ground floor level. In the core the number of inter-linkages between entertainment and other land use types was reduced from 6 to 3, between furniture and other types from 5 to 1, between general merchandising and other types from 4 to 1 and so on. However new linkages were formed between wholesaling, professional, residential and automative activities and these formed a completely distinct cluster of activities. Table 5.8 contains the Spearman rank correlation coefficients which compared the rank of significant correlation coefficients in the planned area with the rank of the same land use associations in the core area.[1] The

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1. The same land use had to be maintained for consistency. However this often introduced some error since that land use correlation was not always significant in both areas.

TABLE 5.8

COMPARISON OF LAND USE STRUCTURE IN PLANNED

AND CORE AREAS - rho values*

Year	Ground	Ground/First	First
1972	0.78	0.76	0.54
1967	0.96	0.70	0.57
1958	0.86	0.96	0.66

* all significant at the 5% level.

TABLE 5.9

POPULATION AT THE CENSUS YEARS

CITY OF WOLLONGONG

Year	Population
1911	24,940
1921	32,381
1933	42,853
1947	62,960
1954	90,852
1961	131,754
1966	149,506
1971	161,143

Source: NSW Yearbook.

The rho coefficient of 0.78 indicates that although the ranks were not significantly different there was some degree of difference.

In comparing the negative coefficients it may be observed that none of the dissociations present in the planned area were significant in the core. Instead a new series of dissociations was formed between automotive activities and entertainment, food, apparel, other retailing, finance, and general merchandising activities. This was not remarkable since (i) ground floor residential activities were relatively scarce in the core and (ii) automotive type uses, because of the usually high cost of the purchase involved (or, in the case of service stations, the wide distribution of outlets) derive little, if any, net benefit from location near primary traffic generators.

In comparing the ground floor/first floor affiliations it may be observed that the same land use types entered the affiliations in the core and planned areas. However the rankings did differ to some extent, as indicated by the rho value of 0.76, and there were 15 fewer significant linkages in the core area. The largest reduction in linkages occurred in apparel activities, where links with ground floor activities decreased from 6 to 2 and in wholesaling activities whose links reduced from 6 to 3. In the group of negative coefficients, however, only 2 of the dissociations which were significant in the planned area - those between first floor residential and ground floor professional activities and first floor entertainment and ground floor community service activities - was also significant in the core. New dissociations were apparent between community service, entertainment and wholesaling activities on the first floor, and automotive and community service activities on the ground floor.

At the first floor level there were 16 significant linkages in the core, compared with 21 in the planned CBD. Also, fewer land use types entered the affiliations in the core where neither general merchandising nor residential activities had significant links. The rho coefficient of 0.54 indicates that there was a considerable difference in the ranks of the coefficients.

Higher order activities require a large market area in order to carry on business at a satisfactory level. As the population of a city increases the potential market area of a CBD location becomes increasingly attractive for higher order activities. Over the study period Wollongong's population increased from 90,852 to 161,143 (Table 5.9) which represented a population growth rate of more than two percent per annum - one of the highest growth rates of any urban area in Australia. The land use changes which this tended to encourage have been described in Chapter four. It may be expected that such land use changes would tend to bring about, either directly or indirectly, an alteration in the land use structure.

The evidence presented in Tables 5.2 - 5.7 suggests that there was a considerable alteration in the land use pattern in central Wollongong. For instance, in the planned CBD the number of ground floor links decreased from 30 in 1958 to 20 in 1972; the ground floor/first floor affiliation decreased from 80 to 53; and the first floor links decreased from 46 to 21. Perhaps the least change occurred on the ground floor in both planned and core areas. Here, between 1958 and 1967 there was a reduction of 9 links in the planned area and 1 in the core. There was a reduction in the number of land use types entering the affiliations in the planned area between 1958 and 1967 when automotive, wholesaling and professional activities had no significant links. The decrease in the number of significant linkages (for all types of linkages) suggests that there was an increase in area specialisation throughout the study period.

(iv) A competitive hierarchy of land use types

For the present study the mean rent per block on each floor level was obtained. For both the planned and core areas a correlation coefficient was obtained between this rent and the number of establishments in each land use type. This coefficient indicated the extent to which the numbers of each activity would vary with the level of the rent. The variation in the number of each land use type with the variation in rent provides an indication of which land use types derive the greatest benefit from location in the streets of highest potential business volume. In one way it may be said that a ranking of the coefficients indicates a competitive hierarchy of land use types. This hierarchy does not indicate which land use individually paid the highest price for floor space, rather it indicates the arrangement of land uses which consistently secured floor space in street blocks with a high mean price.

The correlation analysis was undertaken for ground and first floor levels for each year for both planned and core areas and the results are shown in Tables 5.2 - 5.7. In 1972 the competitive hierarchy on the ground floor in the planned CBD was - apparel, food, general merchandise, entertainment and personal service, other retail, furniture and finance activities. That is, although each of these activities varied directly with the level of rent, the number of apparel activities did so more consistently than did the numbers of food stores, and so on... In one sense this may suggest that apparel activities were more consistently successful in obtaining relatively high priced floor space than were food stores, and so on ...

In the core area at the ground floor level apparel activities were again number one on the hierarchy. Although there were no other significant rent coefficients the ranks in the two areas were compared and a rho value of 0.66 indicated that the ranks differed to some degree (although they were not significantly different). At the first floor level the hierarchy consisted of professional, community service, entertainment and personal and apparel activities.

From the tables it may be observed that there was a significant alteration in the competitive hierarchy between 1958 and 1967, but the change was not as great between 1967 and 1972. The competitive hierarchy in 1958 was as follows - entertainment and personal service, other retailing, furniture and appli ance, food, apparel, professional, and finance activities. In 1967 the order was apparel, general merchandising, food, other retailing, entertainment and personal service, finance and furniture and appliance activities. A rho value of -0.61 indicates that there tended to be a reversal (not significant at the 5 percent level) in the competitive hierarchy over this period. In the core area for the same period a rho value of 0.16 indicated that there was a random association between the ranks in the 2 years. The rho values for the 1967 and 1972 period for the planned and core areas were 0.89 and 0.75 respectively, suggesting that the greatest change in internal structure occurred in the 1958 to 1967 period.

(v) Variation in the number of land use types as distance from the PLV site varies.

Using the concentric zones constructed in Chapter one, the number of each land use type in each zone was observed and a correlation coefficient was obtained between the number of land uses in the zone and the radius to the circumference of the zone. The results for 1972 are presented in Table 5.10 (Section a). These coefficients indicate the extent to which the numbers of each type of land use increase or decrease with distance from the PLV site. Since the zonal concept is used the variation in all directions simultaneously is considered. For any practical purpose this zonal concept of land use variation is of limited usefulness (although it does indicate the extent of land use variation in the 'ideal' land value case). These coefficients were therefore also calculated for the variation along Crown and Keira Streets (the core of the city) whence the zonal distances are more meaningful in terms of walking distance from the PLV site. These results for 1972 are shown in Table 5.10 (Section (b) and (c)).

In Table 5.10 (a) it is apparent that only two coefficients were significant as the five percent level on the ground floor in 1972, those for apparel and automotive land use types. The coefficients indicate that the number of apparel land use activities decreased with zonal distance from the PLV site whilst the number of automotive and related activities increased. This is suggesting that generally, apparel and associated activities are to be found on high priced land near the centre of the city while automotive and related activities prefer cheaper land near the periphery of the core. On the first floor the sign of the coefficient indicates that the number of residential activities increased with distance from the PLV site.

TABLE 5.10

LAND USE/DISTANCE CORRELATION COEFFICIENTS

	(a) CBD[1]						(b) Crown Street[2]						(c) Keira Street[2]					
	1972		1967		1958		1972		1967		1958		1972		1967		1958	
Land Use	G*	F*	G	F	G	F	G	F	G	F	G	F	G	F	G	F	G	F
Food	.54	.61	.08	-.61	-.30	-.14	.39	.42	.26	-.42	.07	.10	-.18	.42	-.39	-.28	-.36	-.28
Merc	-.47	-.41	-.64	-.46	-.20	-.69	-.41	-.38	-.47	-.43	-.22	-.45	-.42	-.14	-.42	-.42	0	-.42
Appa	-.63	-.78	-.73	-.49	-.83	-.85	-.34	-.37	-.46	-.37	-.61	-.63	-.59	-.42	-.44	.14	-.44	-.06
Furn	-.32	0	-.38	-.49	-.46	-.22	.11	0	-.03	-.42	-.65	-.17	-.33	-.28	-.36	-.14	-.49	-.14
Auto	.89	-.20	.81	-.61	.14	.61	.66	-.14	.40	-.42	.05	.42	.29	.14	.71	0	0	.42
Othr	-.25	0	-.08	-.72	-.86	-.43	.25	0	.07	-.48	-.46	-.33	-.35	.14	-.39	-.42	-.57	-.32
Whsl	.14	-.59	.38	-.87	26	-.37	-.28	-.48	.28	-.45	.35	-.14	-.27	-.09	0	-.44	-.45	-.42
Fnce	-.53	-.49	-.60	-.86	-.59	-.90	-.03	-.48	-.13	-.67	-.27	-.49	-.40	-.30	-.36	-.24	-.39	-.43
Prfn	-.03	-.51	.03	-.55	-.21	-.72	.35	-.34	.35	-.39	.12	-.39	-.24	-.34	-.17	-.37	-.29	-.31
Csvc	-.02	-.12	.07	-.12	-.66	-.54	.66	.08	.59	.33	.39	-.49	.09	-.44	.08	-.44	-.09	-.28
Centr	.40	-.47	.46	-.35	-.47	-.63	.32	-.09	.24	-.40	.17	-.37	-.50	-.61	-.50	-.59	-.60	-.53
Rsdn	.43	.52	.33	-.39	.39	-.09	.42	.37	.59	.44	.52	.27	.05	-.17	-.04	-.12	-.03	-.13

(1) = 10% level of significance 0.58

(2) = 10% level of significance 0.48

*G = ground floor

*F = first floor

Table 5.10 (b) indicates that in 1972 along Crown Street the number of automotive and community service land use types were significantly correlated with distance from the PLV site at the ground floor level. An unusual feature at the first floor level was the significant negative coefficient for both financial and wholesale type land use. One would expect wholesaling to be located closer to the periphery.

Again in Table 5.10 (c) it may be observed that in 1972 at the ground floor level the number of both apparel and entertainment land use types decreased with distance from the PLV site, while the number of entertainment land use types also decreased at the first floor level.

Similar coefficients for 1958 and 1967 are also shown in Table 5.10 (a). In 1958 at the ground floor level apparel, financial, other retail and community service land use types had significant negative correlations with zonal distance, while in 1967 apparel, general merchandising and financial land use types had negative correlations and automotive land use types had a positive correlation with zonal distance. Results may be obtained in a similar manner from Table 5.10 (b) and (c).

There are several interrelated features of Table 5.10 upon which comment may be made. Firstly the large variation throughout the study period in land use types with significant relationships suggests that the internal land use structure was undergoing considerable change in that period. This variation is illustrated in Table 5.11. The second point is that the relatively low proportion of land use types with significant relationships in any one year suggests little physical structuring with respect to distance from the PLV site. This is also illustrated in Table 5.11.

TABLE 5.11

VARIATION IN LAND USE TYPES WITH SIGNIFICANT RELATIONSHIPS

CROWN STREET, GROUND FLOOR

Land Use	1972	1967	1958
Auto	0.66	-	-
Csvc	-.66	0.59	-
Merc	-	-.47	-
Appa	-	-.46	-.61
Rsdn	-	0.59	0.52
Othr	-	-	-.46

CROWN STREET, FIRST FLOOR

Land Use	1972	1967	1958
Whsl	-.43	-.45	-
Fnce	-.43	-.67	-.49
Merc	-	-.43	-.45
Othr	-	-.48	-
Rsdn	-	-.44	-
Appa	-	-	-.63
Csvc	-	-	-.49

C.B.D., GROUND FLOOR

Land Use	1972	1967	1958
Appa	-.63	-.73	-.83
Auto	0.89	0.81	-
Merc	-	-.64	-
Fnce	-	-.60	-.59
Othr	-	-	-.86
Csvc	-	-	-.66

C.B.D., FIRST FLOOR

Land Use	1972	1967	1958
Rsdn	0.58	-	-
Food	-	-.61	-
Auto	-	-.61	-.61
Othr	-	-.72	-
Whsl	-	-.87	-
Fnce	-	-.86	-.90
Merc	-	-	-.67
Appa	-	-	-.85
Csvc	-	-	-.54
Prfn	-	-	-.72
Entr	-	-	-.63

Finally, the variation in the magnitude and sign of the correlation coefficient of specific land use types over the period may indicate a change in the businessman's notion of a desirable location for those land use types.

Lets consider this latter point. The 'food' land use category changed from a not significant negative correlation to a significant positive correlation over the period. Although the correlation coefficients in Crown and Keira Streets were not significant the change in these coefficients, coupled with the above change for the CBD as a whole, appears to indicate a decreasing tie which this activity has for the central part of the CBD. A possible explanation for this may be that the growth in the attractiveness of the CBD as a whole (i.e. for other commercial land uses) may make a current peripheral location (or at lease a location a little further from the PLV site) for this type of land use as desirable (in terms of profit) as a more central location fourteen years previously. This change would be brought about by the increased rentals (brought about by increased competition for the floor space desired) 'forcing'[1] this type of land use either towards the periphery or into regional/suburban centres.

The correlation coefficient for 'Apparel' type land use changed from a high negative to a low negative value for the CBD and for Crown Street and a similar direction of movement may be observed for 'Furniture' type land uses (Table 5.10). Again, a similar explanation to that advanced for 'Food' may be put forward in these cases. The 'conflicting'

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1. This notion of land uses being 'forced' out is discussed in Chapter ten below.

feature for 'Apparel' activities in Keira Street was the change from a low negative to a high negative correlation coefficient. This may be due to the fact that floor space along Keira Street tended to be cheaper than floor space along Crown Street for any given distance from the PLV site. Thus, if the choice for the businessman was between moving further from the PLV site along Crown Street, or remaining the same distance from the PLV site but shifting to Keira Street[1] (or, even if an actual 'shift' was not involved, at least choosing Keira in preference to Crown for an initial location) then some firms may choose the Keira Street location.

5.4 Conclusion

The discussion in this chapter was concerned with the competition for floor space in the Wollongong CBD. Analysis commenced with a consideration of the broad question - why do firms demand floor space in a business centre (any such centre) or amongst a group of firms (rather than prefer some uniform distribution amongst the potential market)?[2] In a search of the literature it was found that a similar problem had been examined at an abstract level by Hotelling in the late twenties. Hotelling's thesis, however, was found by a number of writers to have several implications which made it unacceptable for the solution of the clustering problem. In an attempt to avoid the pitfalls associated with Hotelling's work a model was constructed, which incorporated both competing and non-competing goods, showing why retailing firms

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1. At rentals comparable to the further distance along Crown.

2. Chapter six below examines the impact which this demand may have on per unit floor space rents.

tend to group or cluster. It was suggested that this model had probably been implicitly accepted in the literature for some time, although it did not appear to have been presented explicitly.

The chapter then went on the consider the land use structure in the Wollongong CBD. If areas of similar locational desire exist, it was suggested that a street block would be a suitable representation since roadways create obstacles to consumer mobility. The rationale for this is simple. If the volume of pedestrian traffic decreases away from the PLV point it is more likely to decrease perceptibly from one block to the next than it is from one site to the next.[1] In examining the land use structure the evidence strongly suggested that certain land use types tended to locate near each other (i.e. in the same street block) and hence to compete consistently for available floor space. Such land use types were isolated for each year. There were also certain land use types which appeared to 'avoid' each other, similarly these were specified. Also isolated was the hierarchy of land use types which consistently captured the most expensive floor space. Overall, the evidence indicated that each street block in the CBD may be regarded as a sub-market in the CBD property market. The non spatial forces which may lead to a land variation within such sub-markets are considered in the following chapter.

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1. If the street block is uninterruptedly very long then this rationale may not be appropriate. The 'rationale' in that case may be some notion of a 'comfortable' walking distance from the nearest car park.

PART III

BARGAINING POWER AND LOCATION AS FACTORS INFLUENCING THE DETERMINATION OF SITE VALUES

CHAPTER

Part III undertakes the primary task of ascertaining the influence of bargaining power in the determination of land values. The analysis commences with a consideration of the determination of floor space rentals as it is assumed that the demand for land is derived from the use to which the land may be put. The analysis then progresses to a consideration of site value, which has been defined residually.

CHAPTER 6

RENT DETERMINATION IN A SMALL SPATIAL UNIT - AN AREA OF SIMILAR LOCATIONAL DESIRE

6.1 Introductory Statement

It was suggested in Chapter three that, since existing spatial models of land value determination apparently fail to explain land value variation within small areas[1] - areas of similar locational desire - then the existence of any land value differences within such areas may be due to some market force which does not depend on location with respect to the PLV site.[2] The present chapter considers one such market force.

Recall from Chapters one and two that it was Alonso's intention to provide a benchmark against which deviations from the ideal may be compared. The usefulness of the Alonso model as a benchmark, however, need not be limited to spatial deviations. The assumptions of the Alonso model are such that it differs from a perfectly competitive one only in so far as location differences ensure that the commodity traded is not homogeneous. Again, such a state may be utilised as a benchmark against which deviations may be compared. It is hypothesised in the present chapter that one such deviation is a difference in bargaining power between buyer (tenant) and seller (landlord). Essentially the aim of the chapter, then, is to establish that per unit floor space rents depend, inter alia, on the bargaining power of either the landlord or the tenant.

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1. At least in the Wollongong CBD.
2. There is no other suitable focus in the Wollongong CBD.

With this purpose in mind the discussion is considered in three parts. In Section 6.2 it is demonstrated from the literature that the concept of bargaining power as a factor in the rent determination process is not new. It is suggested that there are a variety of ways in which bargaining power may be defined, but in the present discussion bargaining power is defined in terms of one of the negotiating parties having some measure of monopolistic or monopsonistic control.

In Section 6.3 the bargaining model is developed. Bargaining power in the present context depends on the supply/demand interrelationship - the availability of certain sized floor space in relation to the demand for that space. If the supply of a particular size of floor space is excessive then the tenant is in a position to demand a lower per unit rental than may be obtained with another size of floor space (whose supply is not excessive). The position is reversed in a case of insufficient supply. The supply/demand position is established in the first instance on a CBD wide basis, but its impact falls on individual properties (in terms of the rents determined).

The final section of the chapter is concerned entirely with statistical tests of the model. Tests are carried out at ground and upper floor levels and with both retail and office type activities. The broad finding is that the evidence presented in the current chapter, together with that presented in Chapter three, suggests that, although spatial land value models fail to explain the determination of rents (either land or floor space) in the street block sub-markets, when bargaining power is incorporated into the analysis a satisfactory level of explanation may be obtained.

6.3 Bargaining Power and Rent Determination

The variation in bargaining power is but one imperfection in an imperfect system. For Wollongong, however, in the matter of rent determination it appears to be a vitally important imperfection.

Bargaining power may be defined in a variety of ways. Those firms which are nationally (rather than locally) oriented, financially sound, or more reputable tend to be able to demand more favourable treatment in rent negotiations than do small local firms. On this point Turvey notes "... it is only ... large firms ... (whose reliability as tenants is unquestioned) which can obtain a lease even though their bid is not the highest".[1] In such a situation the bargaining strength lies with the large nationally reputable tenant.

Bargaining power may also depend on the extent of information possessed by one of the negotiating parties. For instance Barlowe notes that

> Sometimes the tenant has only fragmentary knowledge concerning the rent producing capacity of the land; sometimes neither party is apprized of the facts; sometimes institutional factors interfere; and sometimes there is little opportunity for the landlord and tenant to bargain as equals . . . The rental bargaining process may involve sharp negotiations in which each party argues his position, or it may involve the placid acceptance of terms already determined by the landlord. In either case the problem of inadequate knowledge causes many landlords and tenants to guess at what is a fair rental.[2]

Bargaining power may also be defined in a more conventional manner - one of the negotiating parties may have some measure of monopolistic or

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1. Turvey, op.cit., p. 15.

2. Barlowe, op.cit., pp. 167-168.

monopsonistic control. It is in such a manner that bargaining power is defined in the present context. Here bargaining power in each size category depends only on the number of tenant-units of space demanded and the number of tenant-units of space offered. This is considered again below. For the moment, however, suffice it to point out that there is nothing revolutionary or extraordinary concerning the manner in which bargaining power is here defined. Indeed, an examination of the rental market shows that fluctuations in rent are in accordance with the above condition. As Barlowe has suggested "Landlords tend to make rental concessions during those periods when the supply of tenants is low. When the opposite set of conditions prevails, landlords often increase their demands and tenants may actually assist them by bidding up contract rent levels".[1]

In a system subject to such imperfections it would not be unusual to expect that lags in the adjustment of rent to market conditions would cause contract rent to diverge over time from economic rent.[2] Economic rent in this instance would be the expected net annual rate of return to the user, or an approximation, determined by bargaining, within the range limited by the landlord's expectations and the tenant's expectations. The economic rent would tend to equality with the annual cost, including normal profit, of providing and maintaining the premises, as estimated at the time of drawing up the contract. Thus, contract rent will approximate this economic rent at the time the contract is determined.

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1. Ibid., p. 167.

2. See the discussion on economic rent and contract in Chapter one above and in Chapter two page 27.

Until a new contract is exchanged economic rent may diverge from contract rent. If economic rent should decline relative to contract rent, that is, if the market expectations change, then the tenant will find himself sacrificing some of the return that should go to his labour, management and capital.

6.3 The Model Adopted

The primary hypothesis to be tested in this chapter is that, at the street block (or other small area) level, relative bargaining strength between landlord and tenant, as well as general and special accessibility (in the restricted sense defined below), is an important factor in commercial rent determination. The analysis adopts the following assumptions:

(a) Each firm in the central city has the desire to be generally accessible. Within the confines of the central city this will be taken to mean a minimum of walking distance from the peak land value site.[1]

(b) Some firms have a desire for special accessibility. Here this will be defined in two ways: (1) a desire to locate on the ground floor since this is more accessible to passing trade than upper or lower floors; (2) a desire for a corner location since this may be passed by two streams of traffic. This is a more restricted conception of special accessibility than that employed by Turvey. To Turvey special accessibility meant "... nearness to particular complementary facilities".[2] It is also a more restricted conception than that of general accessibility

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1. This assumption is adopted in order to again test the Alonso model, this time using floor space rents. See Section 6.4 below.

2. Turvey, op.cit. pp. 48-49.

above. This is so since some firms, particularly those concerned with certain types of office activity, may be indifferent as to whether they locate on the ground floor or the tenth floor, so long as they are generally accessible (accessible to other firms, as well as individuals, with whom they may transact business). It tends to be retailing activities, or those office activities highly geared towards passing trade (e.g. banking), which tend to desire ground floor and corner (ground) locations.

(c) For each firm there exists an optimum quantity of floor space. This is optimum in the sense that any smaller quantity would reduce business turnover more than the savings in the cost of the floor space; any larger quantity would result in an increase in turnover which would be less than that required to compensate for the increased floor space costs. An alternative manner in which this may be stated is in terms of response to price. An increase in the price of floor space implies that business turnover, in relation to the aggregate cost of space, is insufficient to justify the quantity of space utilized. That is, space used is greater than the optimum requirement at that per unit price. A reduction in floor size implies that marginal cost will decrease more than marginal revenue. Thus there will be a downward adjustment in floor space size and the loss in business turnover is justified by the increased profits. The opposite effect may be described for a price increase. The optimum quantity of floor space required can change over time.

(d) Within any range (category) of floor space sizes there will be a number of firms whose optimum lies within the range.

(e) Quality of floor space; prestige; topography; and land use associations are constant.

(f) Bargaining strength between landlord and tenant depends only on the number of tenant-units of space supplied in relation to the number of tenant-units of space demanded (i.e. such factors as tenant reputation are ignored).

(g) Both landlord and tenant have knowledge of their relative bargaining strengths.

(h) No one landlord is large enough to be able to spread his risks throughout all size categories.

(i) Landlords compete with each other for available tenants (competition takes place only in the form of rent changes), and there is no collusion on the part of the tenants.

(j) Relocation costs to the tenant are nil.

(k) The cost of floor space forms a significant part of the tenant's overall cost structure.

Consider bargaining power. A basic argument in the literature on temporal rent changes is that rent will depend on the demand in relation to the available supply (the vacancy rate). It has been shown that there is an inverse relationship between the vacancy rate and the rate of change of money rents.[1] Ross and Wilson have shown that in a market for

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1. Cf. Blank, D.M. and Winnick, L. "The Structure of the Housing Market", Quarterly Journal of Economics, Vol. LXVII, 1953; Duesenberry, J.S. Business Cycles and Economic Growth, McGraw-Hill, New York, 1958; Reece, B.F. "A Relation Between the Rate of Change of Money Rents and Vacant Housing", Second Conference of Economists of Australia and New Zealand, Sydney, 1971. The vacancy rate is a proxy variable. The appearance of vacancies is a manifestation of excess supply.

rental housing there existed a lag of approximately 9 months between the appearance of a vacancy rate and a rental change associated with that vacancy rate.[1] It is reasonable to suppose that a lag (not necessarily of the same duration) in rental adjustments to changed market conditions would similarly exist in the central city property market. That is, the per unit rentals existing at a given moment in time will depend on the vacancy rate which existed in some previous period.[2]

The appearance of vacancies in the market for floor space is indicative of a disequilibrium position. Specifically, it is a manifestation of excess supply.[3] In other words, the market will be in equilibrium when the supply of floor space in each size category is equal to the demand for space in that category (and location). However, throughout the entire range of floor space sizes the vacancy rate will not necessarily be the same in all size categories, rather, it will depend on (a) the distribution of tenant optimum floor space requirements (TOFSR) in relation to (b) the distribution of existing floor space sizes (EFSS) - that is, existing in some period t-1. The argument, basically, is that the fewer the tenants in relation to the quantity of floor space

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1. Ross, B. and Wilson, P.J. "An Analysis of Rentals and Vacancy Factors of Residential Properties in Urban Illawarra", Third Conference of Economists of Australia and New Zealand, Adelaide, 1973.

2. Per unit rent is the rent per floor space unit.

3. In reality excess supply exists when the vacancy rate rises above some level which is considered 'normal' or 'expected'. This 'normal' vacancy rate arises due to the fact that, as tenants 'turnover' some floor space may be held vacant for maintenance or repairs, or, there may be vacancies due to the fact that tenants are relocating (rather than there being excess supply). This conception of a 'normal' vacancy rate may differ from landlord to landlord, area to area, or size category to size category. Note, for present purposes, the vacancy rate will be defined as the percentage of vacant leasable space to total leaseable space.

in any given size category the more difficult it will be for the landlord to lease any floor space which becomes available. That is, the appearance of excess supply increases the difficulty which any given landlord has in leasing his floor space in a particular size category. Therefore, the tenant requiring space in that category will be in a relatively better position to obtain a lower per unit rental than that existing in other floor space size categories. Essentially, this suggests that the tenant's bargaining power effectively increases.

Let us consider the manner in which this bargaining power, and consequently the rental structure,may vary as size of floor space offered for sale varies. To keep the analysis simple a uni-modal distribution in both TOFSR and EFSS will be assumed. In that case it may be suggested that, if tenant bargaining power varies then it either increases or decreases as size category increases. Depending on bargaining power, then, per unit rentals either decrease or increase as the size of the lump of space offered for sale increases. In considering the distributions of TOFSR and EFSS there are a number of possible combinations which will yield either of the above bargaining positions.

At the outset consider two cases in which the distributions of TOFSR and EFSS are the same, and ascertain the impact on bargaining power of a unit (i.e. tenant unit) increase in vacancies across all size categories.[1] Firstly, suppose that the distributions of EFSS and TOFSR

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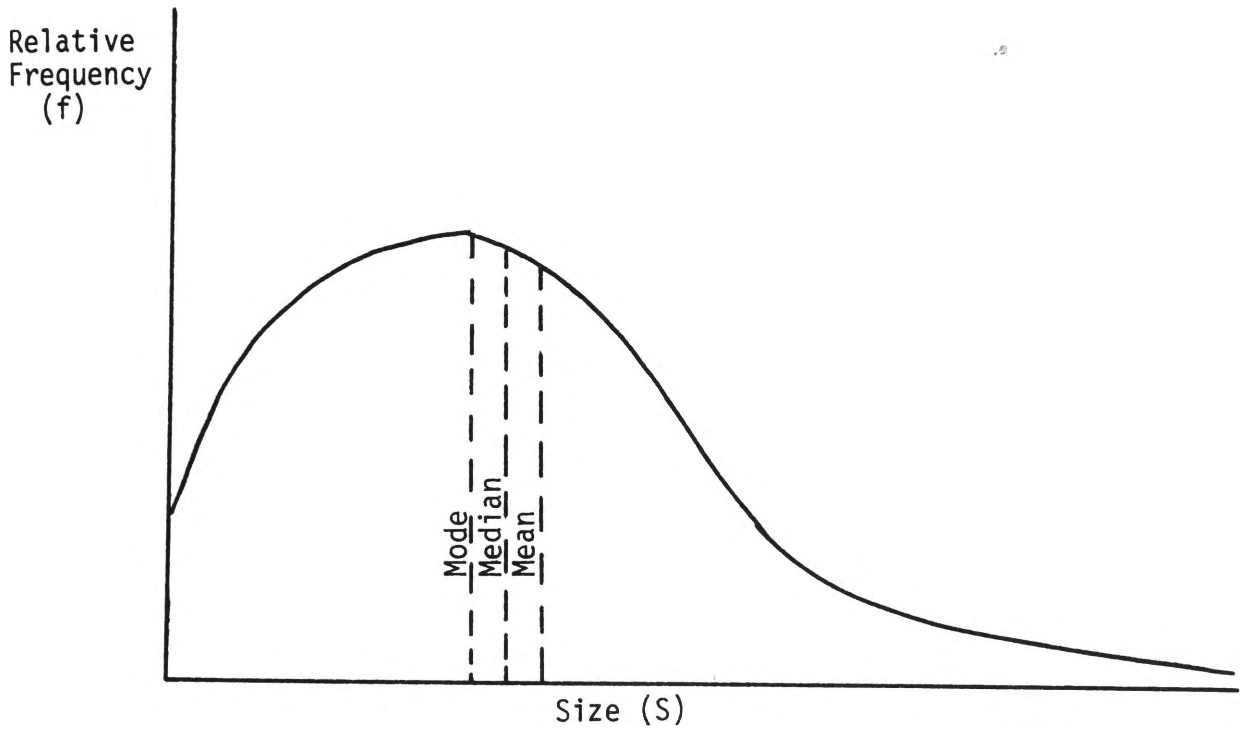
1. That is, persistent vacancies occur across all categories simultaneously. The likelihood of the distributions being the same at any given time (except in the LR) may be expected to be small. The more likely cases are discussed later.

are both positively skewed. Such a distribution type is shown in Figure 6.1. In a positively skewed distribution, as a general rule, as the size category increases the number of firms whose optimum lies in a given range decreases as does the number of tenant units of space supplied.[1]

Figure 6.1



Suppose that in this initial situation supply equals demand in all categories, that is the vacancy rate is zero across the entire range, and that per unit rentals are the same in all categories. Now from this position, if one tenant unit of space fell vacant simultaneously in all size categories (i.e. an 'across the board' one unit increase in vacancies),[2] the vacancy rate would be greater in the upper size categories than in the lower size categories. Thus greater pressure would be exerted on

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1. Despite the fact that the aggregate existing space may not decrease.

2. A rare occurrence. More likely situations are discussed later.

upper size category landlords for a lower per unit rent than that existing in the lower size categories.[1] That is, upper size category tenants would be in a relatively better bargaining position than those in the lower size categories. This may be better explained by a simple example. Suppose in a certain town there are 2 property owners, and each owner has 10,000 square feet of commercial floor space for lease in a single building. One landlord subdivides his space so that it can be leased to 20 tenants (thus one tenant unit of space is 500 square feet) while the other landlord subdivides his space so that it can be leased to only 2 tenants (5000 square feet per tenant unit). Now, when a tenant vacates from the lower size categories the vacancy rate[2] is 5 percent compared with 50 percent when a vacation is from the upper size categories. Thus the upper size category (USC) landlord will be under relatively greater pressure than the lower size category (LSC) landlord to reduce his per unit rentals. (The USC landlord will be in a position to reduce his per unit rents, without lowering his net income below that being

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1. At least for a lower rate of increase in rents, ultimately leading to a per unit rent differential. Note that the argument here and that to be presented below for the second 'extreme' case, will depend on the extent of the skew. That is, the greater the skew the greater will be the consistency in vacancy rates decreasing throughout as size category increases. In a combined normal distribution (i.e. for both TOFSR and EFSS) vacancy rates and hence bargaining power, will decrease towards both tails of the distribution (given a tenant unit increase in vacancies across the board).

2. Defined previously as the percent of vacant lettable space to total lettable space.

obtained by the LSC landlord, if his operating costs per square foot are less).[1] Therefore it may be said that the USC tenant is in a relatively better bargaining position than the LSC tenant.[2]

Suppose, now, that unlike the previous case the floor space sizes form a continuum which ranges in size from say, two hundred square feet per tenant - but the number of tenants in any given size range decreases as the size increases. In this case the potential[3] vacancy rate per tenant unit in any given size range will increase as the size increases, but the difference in vacancy rates between adjacent size ranges will not be as great as in the previous case (nor will the difference in operating costs be as great). Assume that initially equilibrium prevails (supply and demand in each category are equated) and per unit rents are the same throughout all size categories. Suppose that a vacancy of one tenant

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1. One may expect operating costs per square to be lower in the upper categories due to economies of scale (for instance management costs would be less).

2. The analysis is undertaken in terms of relative vacancies (vacancy rates) rather than absolute vacancies so that comparisons as to relative bargaining position may be made. For instance, two landlords may each have a persistent vacancy of 1,000 square feet of floor space. Because of this excess supply both may be pressed for rent reductions. However, will each landlord be under equal pressure for a rent reduction? This will depend on the vacancy in relation to the total lettable space (the relative vacancy). If one landlord has 4,000 square feet of lettable space while the other has 10,000 square feet then the relative vacancies will be 25% as compared with 10%. That is, the former landlord will be under relatively greater pressure than the latter to reduce his rents and lease his vacant space. The model, therefore, would tend to be inoperable if expressed in absolute rather than relative vacancies. This would be so since absolute vacancies may increase as size of floor space leased increases, but if the relative vacanies decrease the USC landlords will be under less pressure for a rent reduction than their LSC counterparts (later discussion in the text considers this case of an increase in USC landlord bargaining power). Note, however, that if the comparison is simply between zero vacancy and positive vacancies the model would be operable if expressed in absolute terms.

3. That is, if a tenant should vacate.

unit occurs across the entire range of floor space sizes. Given that the appearance of a vacancy indicates excess supply then all landlords will be under pressure to reduce per unit rentals[1] (or at least have a reduced rate of increase in ensuing time periods). However, since the vacancy rate increases as size category increases then USC landlords will be under relatively greater pressure than LSC landlords to reduce per unit rentals. That is, tenant bargaining power will increase as size category increases. Given the result established in the literature on the inverse nature of the relationship between vacancy rates and the rate of change of money rents,[2] then a per unit rent differential may be expected to emerge between lower and upper size categories. Specifically, per unit rents may be expected to decrease as size category increases. This, and all future cases in which tenant bargaining power increases (per unit rents decrease) as size category increases (irrespective of skew relative to a normal distribution) will be designated a lower modal distribution (LMD).[3]

Consider, now, a second case in which the distribution of TOFSR and EFSS are the same but this time assume that the distributions are negatively skewed. Such a distribution type is shown in Figure 6.2. Again, from this initial position, assume that the vacancy rate is zero

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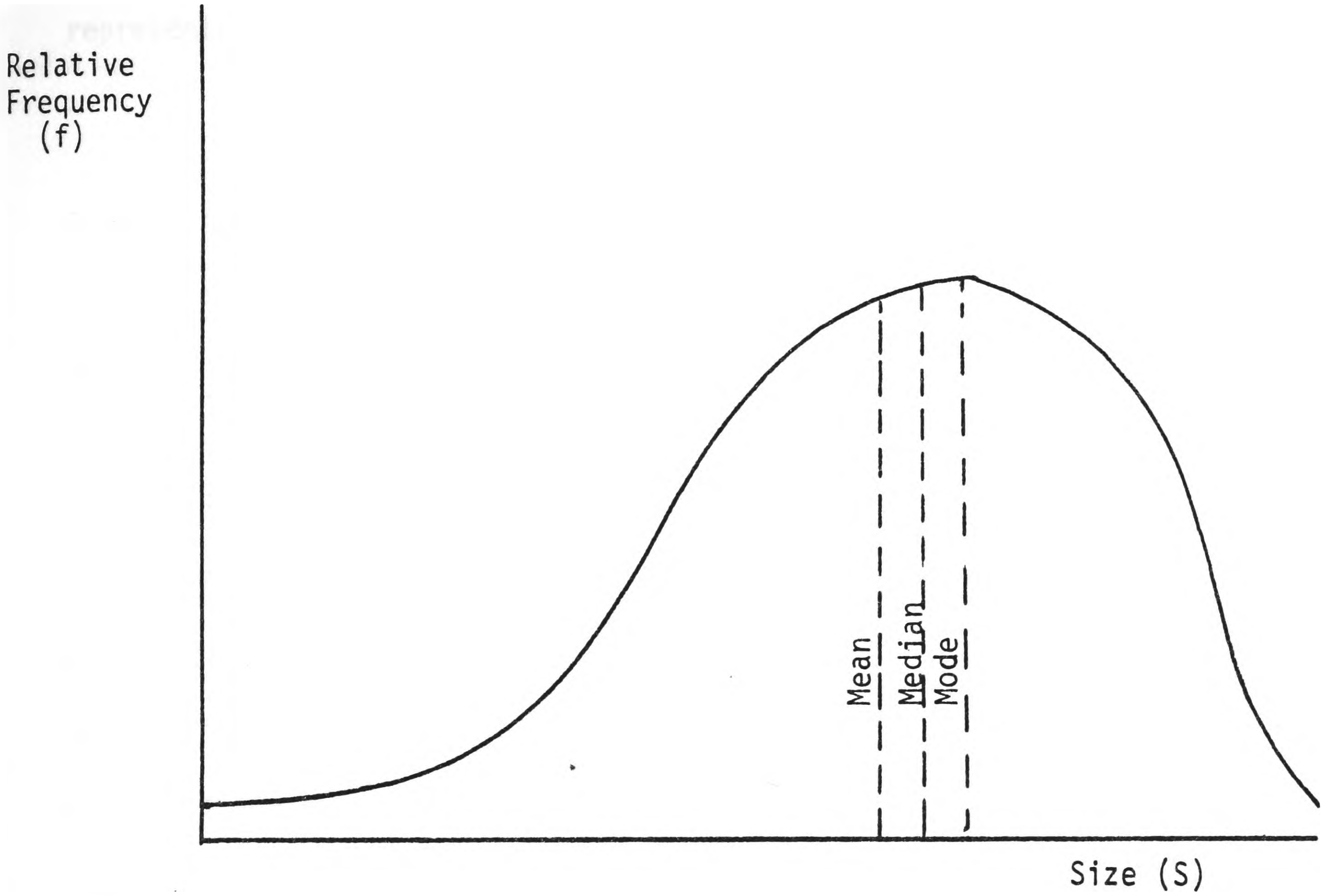
1. Assuming that factors leading to the inverse relationship between vacancy rates and rate of change of money rents, persist.

2. Cf. Blank and Winnick op.cit., Duesenberry, op.cit., Reece, op.cit. and Ross and Wilson, op.cit.

3. The designation is obtained particularly from cases discussed later in which, for the above bargaining position to obtain, the modal class of the demand distribution lies below (i.e. to the left of) the modal class of the supply distribution.

Figure 6.2



across the entire range of floor space sizes and that per unit rentals are equal in all size categories. Now, contrary to the previous case, an across the board one unit increase in vacancies here would result in the vacancy rate being greater in the lower size categories than in the upper. Therefore, relatively greater pressure would now be exerted on LSC landlords for a lower per unit rent than that existing in the upper size categories. Once again a simple example may be used to illustrate this. Suppose there are 200 landlords in a given central city area. One hundred landlords each have 10,000 square feet of floor space leased to 4 tenants (i.e. an average of 2,500 square feet per tenant unit), and 100 landlords each have 40,000 square feet leased to 8 tenants (5,000 square feet per tenant unit). If one tenant unit becomes vacant simultaneously in each category the vacancy rate variation may be represented schematically as follows:

Negative Skew in Distributions of TOFSR and EFSS

Size Category (sq.ft.)	Relative Frequency	Vacancy Rate (%)
2,500	.33	25.0
mean size 4,166		
5,000	.60	12.5

This indicates that, under these circumstances the vacancy rate will be lower in the upper size categories. Thus USC landlords will be in a relatively better bargaining position than LSC landlords. In other words the pressure for a per unit rent decrease will be relatively greater in the lower size categories. Given an inverse relationship between excess supply and per unit rents it may be expected that in the above case per unit rents will decrease as size category decreases.[1]. This and all other cases in which tenant bargaining power decreases as size category increases will be designated an upper modal distribution (UMD)[2].

It would be unusual for the property market to experience an increase in vacancies precisely of the nature discussed above, that is, an equal number of tenant units falling vacant across the board. Therefore the two situations discussed above may be considered to be extreme cases.

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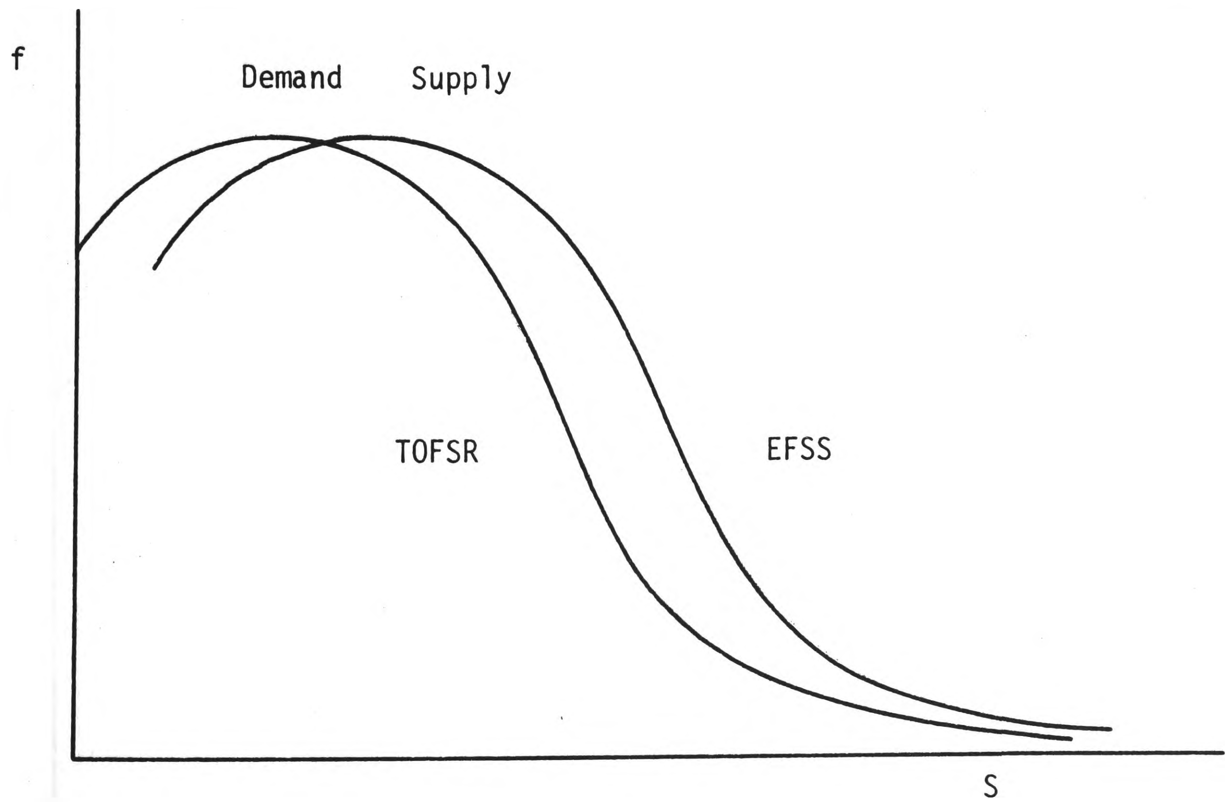
1. Note that in this case if operating costs per square foot decrease as size category increases the USC landlord's net rent will be very much greater than that of the LSC landlord. The adjustment process will be discussed later in this chapter and in Chapter nine.

2. Again, this designation is obtained from the cases to be discussed below in which the modal class of the demand distribution lies above (i.e. to the right of) the modal class of the supply distribution.

In that case let us consider a number of situations which are more likely to arise. First those cases in which the bargaining power of the tenant is greater in the upper than in the lower size categories will be examined. There are three possible combinations of the distributions of TOFSR and EFSS which will yield such a bargaining power variation.[1] Each of these combinations is characterised by the fact that the modal class of the demand distribution lies below (to the left of) the modal class of the supply distribution. Each such combination will be designated a lower modal distribution (LMD) and the three cases are shown in the following diagrams.

Figure 6.3 (a)
Both Positive Skew



1. That is, three apart from the first 'extreme' case discussed above.

Figure 6.3 (b)
Both Negative Skew

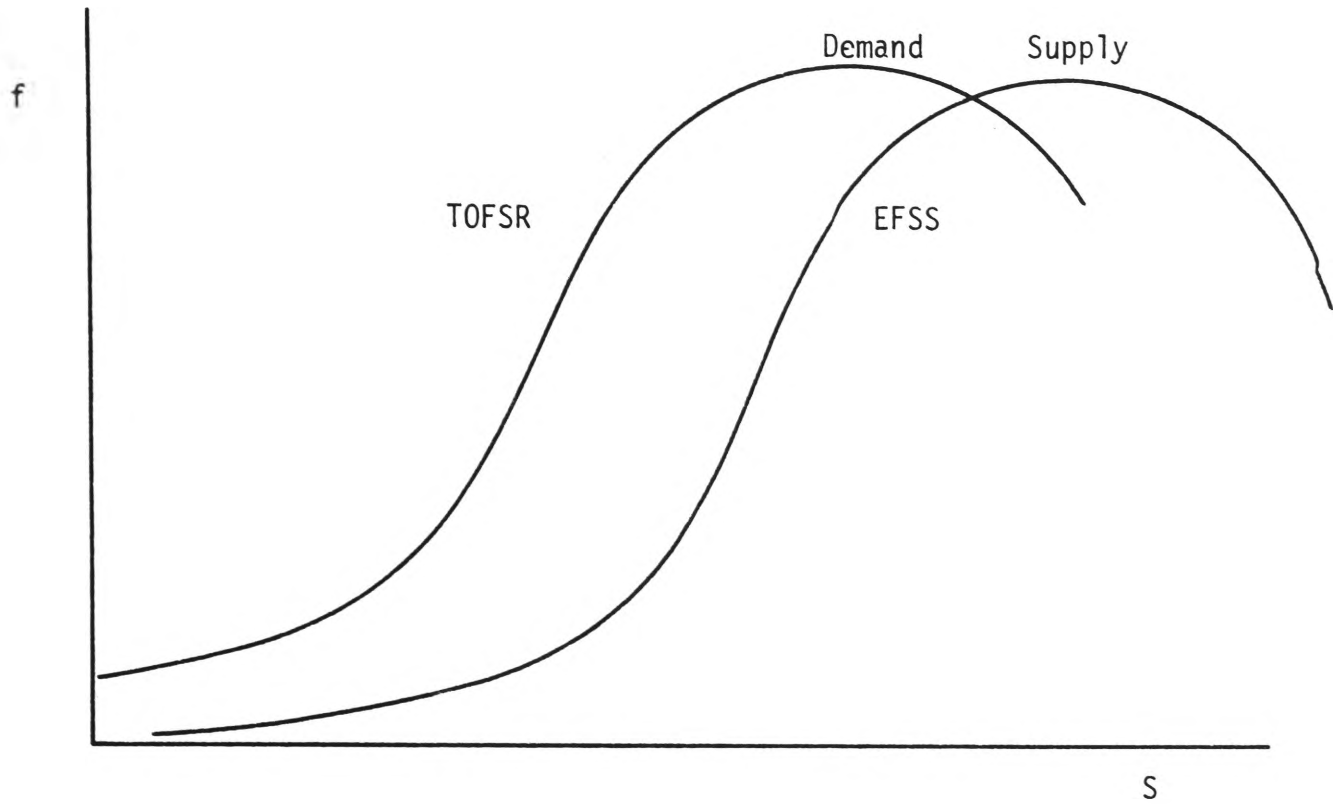
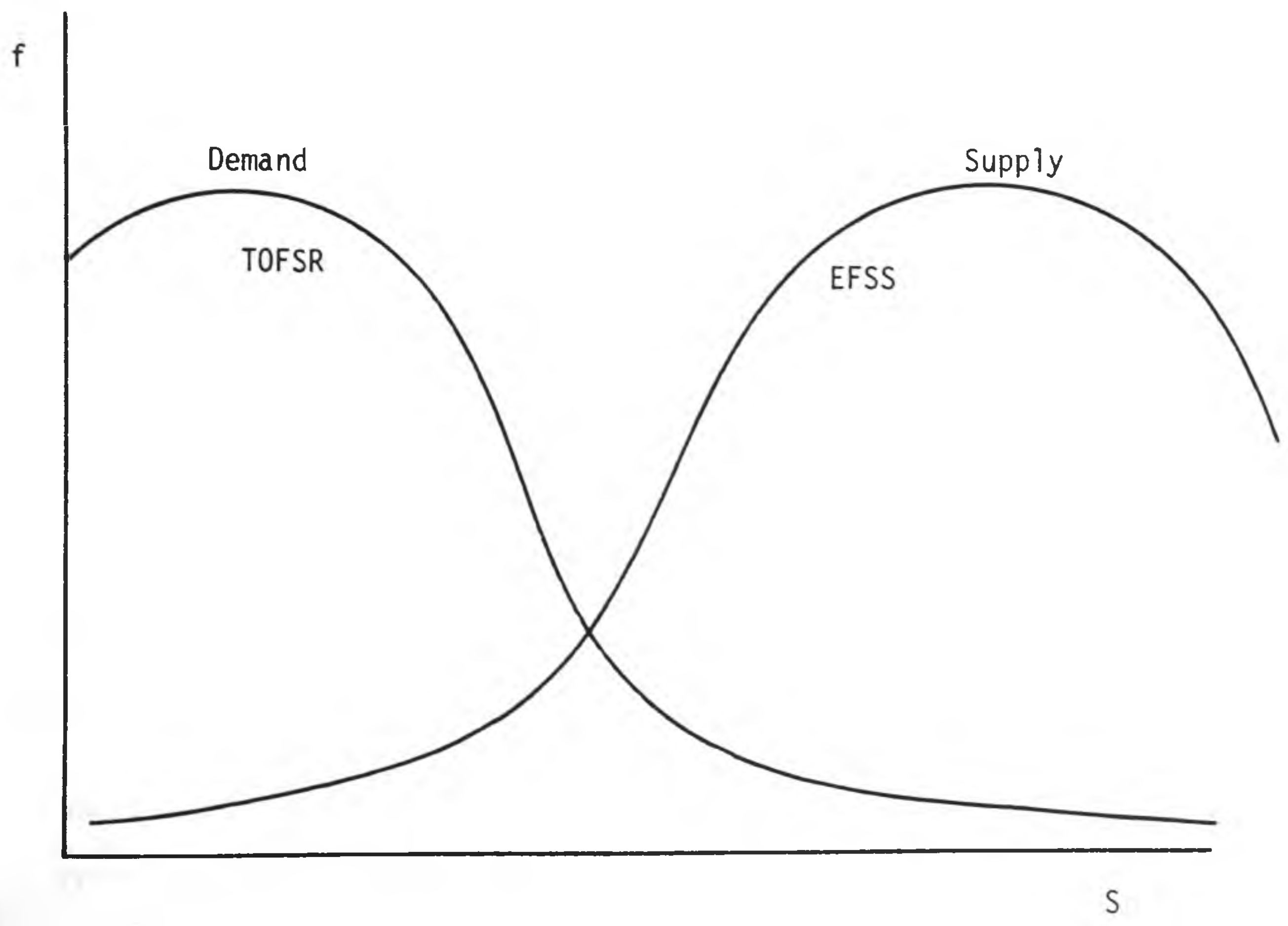


Figure 6.3 (c)
Combined Positive and Negative Skew



In diagram 6.3 (a) the distributions of both TOFSR and EFSS have a positive skew but the distribution of TOFSR is more highly skewed (that is the modal class of TOFSR lies below the modal class of EFSS). In diagram 6.3 (b) the distributions of TOFSR and EFSS each have a negative skew but here the distribution of EFSS is more highly skewed. Nevertheless the modal class of TOFSR continues to lie below the modal class of EFSS. In diagram 6.3 (c) the distribution of TOFSR has a positive skew while that of EFSS has a negative skew. Again the modal class of TOFSR lies below that of EFSS.

The discussion on rent variation in these cases is general[1] and, for present purposes then, the three cases may be discussed as one. Suppose that in the initial situation supply equals demand throughout all size categories (zero vacancy rate) and that per unit rentals are the same across the board. Assume, now that either of the following (or both) occur:

1) the distribution of demand alters so that the modal class of TOFSR shifts to the left of that of EFSS. Such a movement could occur for a number of reasons. For instance an increase in labour costs may lead to a reduction in staff. This reduction in the staff to floor space ratio may imply that the optimum quantity of floor space is now reduced. Or, it may be that there is a decrease in the attractiveness of the CBD to the consumer who now prefers the regional shopping centres etc. The decrease in business turnover to CBD firms may lead to an alteration in their optimum floor requirements ultimately leading to an alteration in the distribution of TOFSR;

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1. That is, to these three cases. Any differences in bargaining among the three cases will be one of degree rather than one of kind. That is, in each case USC landlords will tend to be in a relatively worse bargaining position than LSC landlords.

2) the distribution of supply alters so that the modal class of EFSS shifts to the right of that of TOFSR. This would occur through a greater quantity of floor space coming onto the market in the upper categories than in the lower categories.

Either of the above events will lead to a situation of excess supply in the upper size categories. In this situation LSC landlords will emerge in a relatively stronger bargaining position than USC landlords. That is, until the excess supply has been eliminated,[1] tenants requiring large 'lumps' of floor space will be in a position, during rent negotiations, to demand either reduced rentals or, at least, reduced rates of increase in rentals. On the other hand tenants requiring small quantities of floor space,[2] since there is no excess supply, will not be in a position to demand any rent reduction. Furthermore they may bid against each other for available floor space thereby enlarging the 'gap' in per unit rentals between upper and lower size categories.

In the second group of 'less extreme' cases the bargaining power of the tenant is greater in the lower than in the upper size categories. Again, three possible combinations of the distributions of TOFSR and EFSS will result in such a bargaining power position. These combinations are shown in the following diagrams. In each of the diagrams (Figure 6.4 a, b and c) it may be observed that the modal class of the demand

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1. To be discussed below.

2. The critical size will depend upon the point of overlap (i.e. where the distributions 'intersect') in the two distributions.

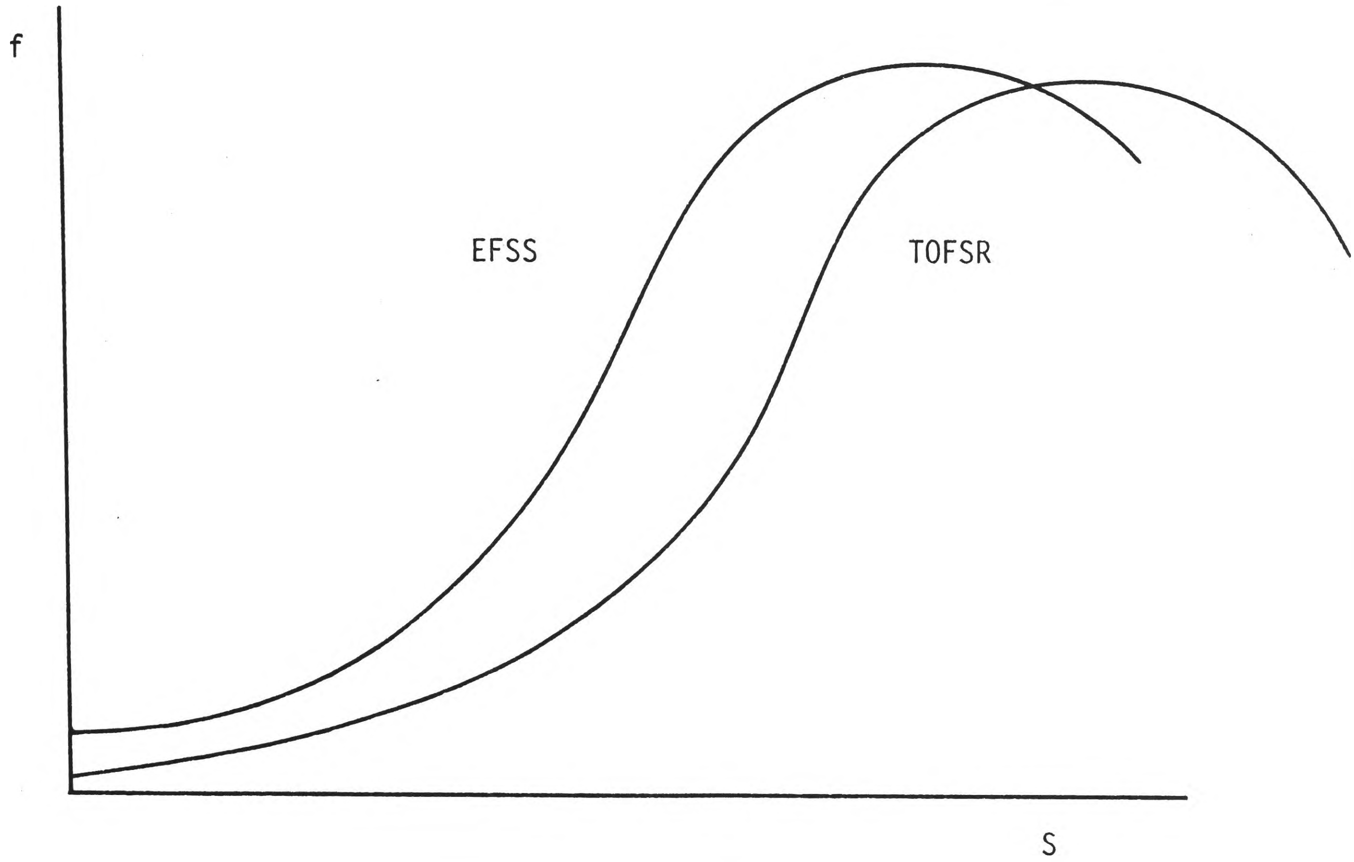


Figure 6.4 (a)
Both Negative Skew

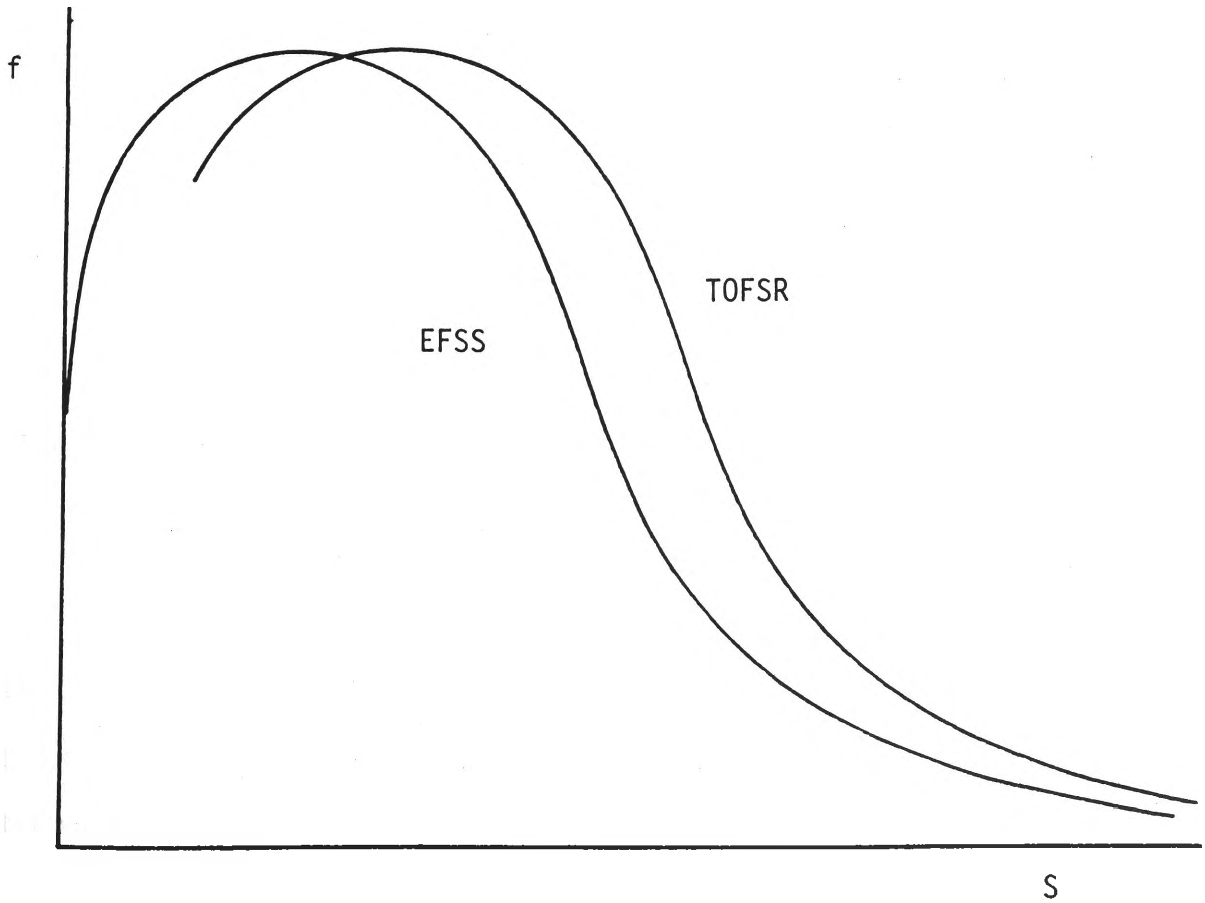
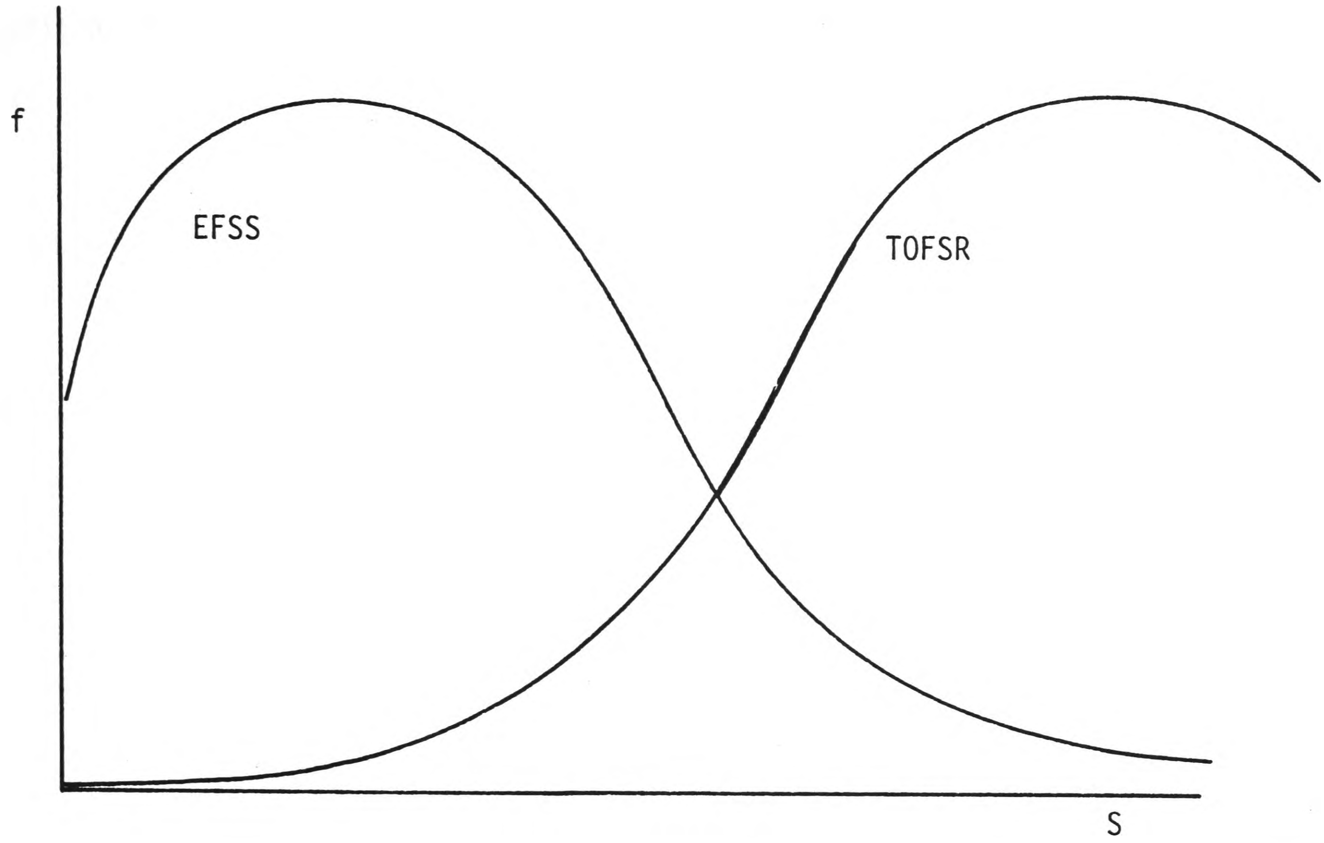


Figure 6.4 (b)
Both Positive Skew

Figure 6.4 (c)
Combined Positive and Negative Skew



distribution, in contrast to the LMD cases, lies above (to the left of) the modal class of the supply distribution. Each such combination may be designated an upper modal distribution (UMD). In each of the above cases excess supply will exist in the lower size categories (again the critical size is determined by the point of overlap). Therefore LSC landlords will be in a relatively worse bargaining position than USC landlords. In the rent negotation process LSC tenants are in a position to demand rent reductions whereas quite the opposite situation exists for USC tenants who may, in fact, bid against each other for available space. Therefore it may be expected that per unit rents will be higher in the upper size categories.

So far only one stage of the process has been considered viz. the movement from an initial equilibrium position. Given that a new rental structure emerges, further adjustment will now take place. This adjustment will be towards equilibrium and will occur on both the demand and supply sides.[1] Adjustment on the supply side will depend on the relative profitability of supplying space to the upper or lower size categories. This notion of profitability, and the impact on supply, will be discussed in chapter nine. In fact little more can be said on supply at this stage until construction costs are discussed in chapter eight.

Consider briefly the expected adjustment on the demand side. The discussion will be general enough to cover each of the cases discussed above. Recall from earlier discussion that the tenant's optimum floor space requirement is not independent of the price of that space. That is, if the per unit rent should change then the tenant's optimum quantity of floor space will also change. Each of the above cases commenced from a position in which per unit rents were equal across the board and each tenant had his optimum quantity of floor space. Let us start the present discussion from such a position. Suppose then that the rental structure alters such that per unit rents increase as size category increases. For some firms, after this change, marginal cost will no longer equal marginal revenue (with respect to floor space). To re-establish this equilibrium it will be necessary for such firms to shift downwards in size category. This will have two effects. Firstly it will take up some of the slack previously existing in the lower size category (i.e. reduce the vacancy rate). Secondly it will create slack in the size category which has been vacated (i.e. increase the vacancy rate). This adjustment process may be expected to continue until per

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1. Note again that equilibrium in the sense that supply and demand are equated across the board may take a long time to be attained because of the nature of the property market (Cf. Turvey, op.cit., p. 47). It is the adjustment towards equilibrium that is being considered here.

unit rentals are again equal in all size categories and the tenant, therefore, no longer has any incentive to shift categories. That is, the adjustment will continue until vacancy rates are equal. This, of course, is not an equilibrium in the sense that supply equals demand since, in fact, excess supply exists. It is more in the nature of a temporary resting place - a 'temporary equilibrium'. In such a situation bargaining power is equal across the board.[1] The adjustment process will be in the opposite direction if per unit rentals decrease as size category increases.

Within the framework of the above model there may be two levels of 'bargaining'. In the first instance the tenant makes a choice to locate in the CBD (rather than some regional/suburban centre, or even another city), that is he demands space in the CBD as such. Since this location decision will be influenced, inter alia, by some notion of an expected rental for the particular size/type of floor space desired, the supply/demand interrelationship for this category of floor space on a CBD wide basis forms what may be called the aggregate level of 'bargaining' (rent negotiations will not take place at this level so that bargaining here is only conceptual).[2] Within the CBD, for that particular tenant (effectively, that particular land use), there may be several possible areas of similar locational desire (SLD). These SLD areas will be determined, inter alia, by the mutually attractive land uses already

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1. The adjustment is towards such a position, although it may never be reached since circumstances are continually changing - demolition, construction, tenants entering and leaving the CBD and so on ...

2. Rent is not determined at this level, nor does any particular chronological significance attach to this distinction between aggregate and individual. However, it is the aggregate of rents determined at the individual level which moulds the 'incoming' tenant's notion of an expected rental (or, perhaps rent range).

located there.[1] If the tenant perceives similar locational advantages in each of these areas,[2] then his decision (ceteris paribus) will be influenced by the availability of the desired category of space. Thus at this small scale the supply/demand interrelationship will be important (if suitably sized space is available in each area, but the supply/demand interrelationship has pushed rentals higher in one area, then the tenant may delete that area from his options). This may be called the individual level of bargaining. Rent negotiations will take place at this level.

Consider now a second variable, that of general accessibility. As discussed in Chapter one this is conventionally laid down in the literature as a major determinant of site rentals. Each firm has the desire to be generally accessible, that is, to be as close to the peak land value site as possible. Since all of the firms cannot be accommodated at the centre they will be distributed throughout the central city on an ability to pay basis. Other things being equal, those firms able to pay a higher per unit rental will occupy the more central positions.[3]

Now, up to this point there are two forces operating to determine the per unit rental paid for floor space at any given location (within an SLD area). One is the relative distributions of EFSS and TOFSR, the other is the distance from the PLV site. Whether the per unit floor space rental at a given location within one SLD area is less than that

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1. Mutually altractive in the sense considered in the previous chapter - that is, it is mutually beneficial in terms of the expansion of potential sales volume for such land uses to locate near each other.

2. Within each area itself the tenant will be indifferent to location.

3. This statement is applying the conventional (site rent determination) argument to floor space rentals. This is certainly valid since, ceteris paribus, the demand for land is derived from the use to which that land may be put.

existing at a given location within a SLD area closer to the PLV site will depend on the size category (in relation to the two distributions). Within a given size category the per unit rental would be expected to decrease as general accessibility decreases. That is, if all floor space was homogeneous with respect to size, ceteris peribus, the per unit rental would be expected to decrease predictably with distance from the centre of the city. However, the joint operation of the two forces may give something of a random appearance to the pattern of per unit rentals. For instance, if USC landlords are in a relatively worse bargaining position than LSC landlords, then it is conceivable that LSC tenants located near the periphery of the CBD may pay a higher per unit rental than USC tenants located closer to the PLV site.

The 'pattern' may be further disrupted by the operation of special accessibility. The conventional meaning of special accessibility is a need to locate near particular land use groupings,[1] for example, Wall Street, New York; Fleet Street, London; or Macquarie Street, Sydney. In the present context, however, special accessibility will be confined to the meanings adopted earlier.

Since some firms have a greater need to be located on the ground floor it may be expected that the per unit rental on the ground floor would be greater than onany other floor. Those activities which desire a ground floor location but are unable to secure it may be satisfied with a 'second best' first floor or basement location provided it is well located with respect to general accessibility. One would expect, then, a general decrease in per unit rental with height above ground. The rental will be prevented from falling to zero and may be expected to be

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1. Turvey, op.cit., p. 49.

held at some constant level because of the influence of general accessibility. Since special accessibility ceases to operate above, say the second floor the only other force in operation (if we assume size category constant in a given building) is that of general accessibility. Therefore, firms will be indifferent to vertical location above the second floor.[1] This simply suggests that for some firms the higher the floor the smaller the cross elasticity of demand between that floor and the ground floor. The cross elasticity of demand between each floor above say, the second, is very much higher than that between floors below the second.

The desire for location on the ground floor is clearly related to the need to be accessible to the passing trade. As the volume of passing trade declines so does the need to be located on the ground floor. Therefore as distance from the point of highest pedestrian traffic declines so does the operation of special accessibility related to ground floor location. Therefore one would expect that with distance from the PLV site the relative difference between ground floor and upper floor rentals would decline. That is, within any size category the rate of decrease in per unit floor space rentals with distance from the centre would be greater for ground floor rentals than for upper floor rentals. However, as long as there is some passing trade it is unlikely that ground and upper floor rentals would be equal.

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1. An exception to this rule may occur where there are exceptional views, or, where there is a certain prestige value attached to an elevated position. For instance the shipping firms in Vancouver attach a certain status scale to height above ground and actively compete for the more elevated positions - resulting in an increasing per unit rental with height above ground. (Discussion, Dr. R. Robinson, Dept. of Geography).

A second aspect of special accessibility has been defined as corner influence. The PLV site is generally a corner location since this is accessible to two streams of traffic. Similarly, other corner locations in the central city are usually accessible to two streams of traffic so that some firms desire to locate on these sites rather than on off corner locations. Such firms may be prepared to pay a premium for these locations. That is, within a given size category the per unit rental may be expected to be higher at a corner location than at a location towards the centre of the block.

6.3 An Empirical Analysis in Wollongong

(i) The Data

Data were obtained principally from the Owner Return Files and Valuation Records at the Department of the Valuer General, Wollongong. Since not all properties were tenanted it was necessary, at times, for the Valuer General to impute a rental to owner occupied properties. A glance at Table 4.9 will show that there were sufficient tenanted properties in the study area for the Valuer to accurately impute a market rental. This table shows the proportion of properties which were owner occupied etc. in the core area in Wollongong. Throughout the study period, on average, 50 percent of the properties had tenants (i.e. were either owner occupied with tenants or completely tenanted).

Only in the core area did each street have sufficient observations (more than 10), thus analysis was confined to the two main commercial streets. Table 6.1 shows that this was not extraordinary since these two streets contained the major proportion of total floor space in each of the study years. In 1972 these streets contained 54 percent of the ground floor space and 63 percent of the first floor space.

TABLE 6.1

PROPORTION OF FLOOR SPACE IN MAIN COMMERCIAL STREETS

(CROWN AND KEIRA)[1]

Year	Basement	Ground	First	Second	Third	Other Upper	Total
1958	0.92	0.77	0.92	0.97	1.00	1.00	0.84
1962	0.91	0.78	0.89	0.98	1.00	1.00	0.84
1967	0.88	0.68	0.84	0.98	1.00	1.00	0.76
1972	0.49	0.54	0.63	0.81	1.00	1.00	0.58

1. Source: Valuer General Owner Return Files.

The table is interesting in that it shows the relative extent of the lateral expansion of the central city. Between 1958 and 1972 the proportion of ground floor space contained in these two streets declined by 23 percent and the proportion of total floor space declined by 26 percent.

The type of distribution of EFSS (in the Wollongong CBD) was gauged by Pearson's second coefficient of skewness.[1]

$$\alpha_2 = 3\frac{(\mu - \omega)}{\sigma} \qquad 6.2$$

where α_2 = Pearson's second coefficient of skewness

μ = the mean size in square feet

ω = the median size in square feet

σ = the standard deviation

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1. Information for this was obtained via Valuer General and Field Survey data.

Application of this formula to the central city data resulted in the area-coefficients of skewness shown in Table 6.2. It may be observed that all of the coefficients are positive. Now, if supply and demand are equated across the board (the distributions of TOFSR and EFSS are the same and vacancies are zero) there will be equal pressure on all rents and thus there will be no variation in per unit rents.[1] Therefore, if there is a variation in per unit rents with size of floor space then it may be inferred from earlier analysis that either an LMD or UMD case exists.

TABLE 6.2

AREA-COEFFICIENTS OF SKEWNESS

YEAR	Mean Size[1]	Standard Deviation[1]	Median Size[1]	Coefficient of Skewness
1958	1892	1785	1139	+1.27
1962	1980	2049	1251	+1.07
1967	1985	2180	1239	+1.03
1972	2350	2189	1420	+1.27

1. Square feet

A three independent variable multiple regression model was used to test the relationship between per unit rents and: distance from the PLV site; size of floor space leased; and corner influence.[2] The regressions were 'run' on a block-by-block basis (areas of SLD). It was shown in Chapter five that consistent land use associations exist at the street block level. It was felt that analysis at the street block level

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1. Even if excess supply exists, but vacancy rates are equal throughout, per unit rents will not vary with size. See section 6.2 above.

2. A standard 1620 package was slightly modified to calculate the partial correlation coefficients between the dependent and independent variables. The package handled six independent variables at a maximum. The modified program is shown in Appendix H. A program was developed to calculate the coefficient of skewness (this is also shown in the Appendix). This program was later 'built in' to the IBM package.

was valid since each block essentially forms a submarket within the central city property market. Within each block tenants compete for available floor space and are motivated by the desire to be generally accessible. Those who can compete successfully in a better located street block will do so, those who are unsuccessful will compete in a less well located street block (i.e. a less well located SLD area).

(ii) Significance of Regressions

Table 6.3 lists the coefficients of multiple correlation for each block in each year.[1] Only 9 of the 46 regressions were not significant at the 5 percent level. Furthermore, 32 of the regressions were significant at the 1 percent level. In more than two thirds of the cases the multiple correlation coefficients were greater than 0.7. Although the explained variation in some streets was extraordinarily low, for instance, the northside of Crown Street between Keira and Church Streets had only 34 percent of the variation explained by the regression, for a number of reasons the results, on the whole, were not unacceptable. It was earlier assumed that such factors as age, prestige, quality of floor space etc. were held constant.[2] This is clearly unrealistic.

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1. The number of observations in each street block fluctuated due to a variety of reasons. Foremost, of course, was demolition and new construction. The most notable case was the removal of floor space from the market to make way for the Abbey Orchard Project. Some tenants in the buildings marked for demolition were able to secure short term leases in order to take advantage of the 1972/73 Christman/New Year season. Fluctuation in the number of observations was also caused by (a) the removal of floor space from the market if its condition made it unsaleable (b) the demolition or construction of partitions by landlords in order to move floor space from one size category into another. For example when Woolworths vacated as a tenant from the Methodist Church building in mid Crown Street the space was subdivided and leased to two tenants.

2. Even if a useful indicator of these had been obtained the number of variables needed would have well exceeded the capacity of the programme.

TABLE 6.3

COEFFICIENTS OF MULTIPLE CORRELATION - GROUND FLOOR[1]

YEAR	Street	Code	R	F-Ratio	Significance[2] 1%	5%
1972	Crown, NS, Railway to Keira	1	0.67	6.9	4.6	3.0
	" " Keira to Church	2	0.93	20.0	6.6	3.7
	" " Church to Kembla	3	0.78	12.2	4.7	3.0
	" " Kembla to Corrimal	4	0.83	13.0	5.1	3.2
	" , SS, Railway to Keira	5	0.72	7.5	4.9	3.1
	" " Keira to Church	6	0.77	5.1	6.2	3.6
	" " Church to Kembla	7	0.81	13.9	4.8	3.0
	" " Kembla to Corrimal	8[3]	0.88	23.1	6.7	3.8
	Keira, WS, Ellen to Crown	9	0.68	1.7	5.7	3.4
	" " Crown to Victoria	10	0.81	2.8	5.7	3.4
	" " Victoria to Campbell	11	0.93	16.2	7.6	4.1
	, ES, Crown to Campbell	12	0.79	6.5	4.6	3.0
	" " Ellen to Crown	13[3]	0.83	7.7	9.6	4.7
1967		1	0.73	10.4	4.8	3.0
		2	0.69	4.7	5.4	3.3
		3	0.79	14.9	4.6	3.0
		4	0.63	4.0	5.1	3.2
		5	0.78	11.1	4.9	3.1
		6	0.68	8.7	6.6	3.7
		7	0.84	22.0	4.8	3.0
		8[3]	0.84	9.9	6.7	3.8
		9	0.76	6.6	7.0	3.9
		10	0.65	2.8	6.2	3.6
		11	0.97	42.6	8.5	4.4
		12)[4]	0.72	6.7	4.4	2.9
		13)				
1962		1	0.67	7.1	4.6	3.0
		2	0.81	9.8	5.4	3.3
		3	0.79	13.6	4.7	3.0
		4	0.70	5.5	5.2	3.2
		5	0.74	8.1	4.9	3.1
		6	0.59	1.8	6.6	3.7
		7	0.87	9.0	5.2	3.2
		8[3]	0.64	4.5	6.7	3.8
		9	0.69	4.6	7.0	3.9
		10	0.73	2.9	6.2	3.6
		11	0.95	21.3	8.5	4.4
		12)[4]	0.75	5.3	4.5	2.9
		13)				
1958		1	0.74	7.0	5.2	3.2
		2	0.58	2.6	5.4	3.3
		3	0.84	9.6	6.0	3.5
		4	0.58	2.6	5.3	3.2
		5	0.68	5.3	5.1	3.2
		6)[4]				
		7)	0.86	17.6	4.5	2.9
		8)				
		9	0.58	1.8	9.8	4.8

TABLE 6.3 (cont'd)

YEAR	Street	Code	R	F-Ratio	Significance[2] 1%	5%
1958		10)[4] 11)	0.78	5.7	5.2	3.2
		12)[4] 13)	0.73	4.9	4.6	3.0

1. Several types of commercial floor space use were included - although the population was composed largely of retail and office type use. Some factory and warehousing type use entered the Keira street data.

2. Source: Snedecor, G.W., Statistical Methods, Iowa State University Press, Ames, 1956, pp.246-249.

3. No corner variables were possible.

4. Less than ten observations not considered - therefore, streets were combined.

First class, air conditioned floor space was analysed alongside floor space which was constructed 50 or more years ago.[1] In the Crown Street instance mentioned above the coefficient of multiple correlation ranged from 0.58 to 0.81 between 1958 and 1967. Yet in 1972, when some floor space had been removed from the market for demolition, the coefficient increased to 0.93. Presumably the least saleable, worst conditioned, floor space was removed first from the market.[2] If this was so then it suggests that, if the floor space could be classified according to quality, then the explained variation brought about by the regression would increase substantially.

Another reason why the coefficients were not exceptionally high may have been as a result of the variety of land use types included. The Crown Street data were composed largely of office and retail type use as was the data in Keira Street from Crown to Campbell. Factory and warehousing type use entered the Keira Street data on the lower side of Crown, that is from Crown to Ellen Streets. If the data were decomposed according to land use type one would expect an improvement in the 'fit' of the regressions. This would be so since some floor space cannot easily be converted from one type of use to another. This friction may be great enough to regard certain land use types as being in completely

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1. Throughout this time period there has been a large increase in the demand for commercial floor space as indicated by the population change from 90,852 to 161,143.

2. Unfortunately the property managers, Lord, Barton and Co., when approached by the author, refused to disclose information of any kind.

TABLE 6.4

COEFFICIENTS OF MULTIPLE CORRELATION - RETAIL ONLY - GROUND FLOOR

YEAR	Street Code	R	F-Ratio	Significance[1] 1%	5%
1972	1	0.66	5.9	4.8	3.0
	2	0.93	20.0	6.6	3.7
	3	0.73	7.5	4.9	3.1
	4	0.84	10.7	5.7	3.4
	5	0.80	9.3	5.0	3.1
	6	0.79	6.4	6.6	3.7
	7	0.85	16.8	4.9	3.1
	8[2]	0.88	18.7	6.7	3.8
	9) 10) 11)	0.94	41.2	5.4	3.3
	12) 13)	0.91	31.6	4.9	3.1
1967	1	0.74	10.0	4.7	3.0
	2	0.69	4.7	5.4	3.3
	3	0.74	9.8	4.7	3.0
	4	0.67	4.1	5.4	3.3
	5	0.85	17.1	5.0	3.1
	6	0.74	7.3	7.0	3.9
	7	0.83	15.2	4.9	3.1
	8	0.99	222.7	6.7	3.8
	9) 10) 11)	0.96	52.4	5.6	3.3
	12) 13)	0.80	11.7	4.9	3.1
1962	1	0.69	7.2	4.7	3.0
	2	0.81	9.8	5.6	3.3
	3	0.92	42.9	4.7	3.0
	4	0.80	8.4	5.6	3.3
	5	0.81	9.6	5.1	3.2
	6	0.62	3.1	7.0	3.9
	7	0.92	21.3	6.0	3.5
	8	0.63	3.6	7.2	4.0
	9) 10) 11)	0.93	28.3	5.6	3.3
	12) 13)	0.83	15.1	4.9	3.1
1958	1	0.78	8.4	5.3	3.2
	2	0.58	2.6	5.4	3.3
	3	0.84	9.6	6.0	3.5
	4	0.63	3.0	5.6	3.3
	5	0.71	4.4	5.4	3.3
	6) 7) 8)	0.85	13.6	5.4	3.3

TABLE 6.4 (cont'd)

YEAR	Street Code	R	F-Ratio	Significance[1] 1%	Significance[1] 5%
1958	9)				
	10)	0.82	6.9	6.6	3.7
	11)				
	12)				
	13)	0.70	9.9	4.9	3.1

1. Source: Snedecor, op.cit.

2. No corner variables were possible.

separate markets.[1] To test this in a crude way the regressions were run a second time using only retail data and the results are shown in Table 6.4.[2] It is noteworthy that in only 4 of the 38 regressions were the results not significant at the 5 percent level. In almost two thirds of the cases the multiple correlation coefficient increased.

Regressions were similarly run for first floor office type use only. These results are shown in Table 6.5. In only 2 cases were the results not significant at the 1 percent level.

TABLE 6.5

COEFFICIENTS OF MULTIPLE CORRELATION - FIRST FLOOR[1]

YEAR	Street	Code	R	F-Ratio	Significance[2] 1%	5%
1972	Crown, NS, Railway to Kembla	1	0.77	11.8	6.2	3.6
	Crown, SS, Railway to Kembla	2	0.83	19.7	6.0	3.6
	Keira, ES, Crown to Flinders	3	0.94	36.1	7.6	4.1
	Keira, WS, Crown to Flinders	4	0.93	49.8	6.4	3.7
1967		1	0.89	31.5	6.2	3.6
		2	0.75	11.8	5.9	3.5
		3	0.51	1.6	8.0	4.3
		4	0.92	38.6	6.4	3.7
1962		1	0.83	14.2	6.7	3.8
		2	0.81	14.4	6.4	3.7
		3	a	a	-	-
		4	0.98	235.7	6.4	3.7
1958		1	0.65	2.9	8.7	4.5
		2	0.82	13.5	6.7	3.8
		3	a	a	-	-
		4	0.99	355.6	6.5	5.6

a. Less than ten observations not considered - opposite sides of street could not be combined.
1. Office type use only. Two independent variables - size and distance.
2. Source: Snedecor, op.cit.

1. This would only be so in the short run. Although space cannot be easily converted from one use to another, this is not to say that space cannot be converted at all. See, for example, Chapter four.

2. Even within the broad spectrum of retail type uses certain floor space may not be easily converted from one type to another. There was insufficient capacity in the IMB package to have a worthwhile land use separation.

(iii) The Regression Coefficients

(a) Ground Floor General

Intercept.

The partial regression coefficients along with their standard errors are shown in Table 6.6. Here it may be observed that more than 90 percent (40) of the intercept coefficients were significantly different from zero at the 5 percent level of significance. Of the regressions which were significant at the 5 percent level more than 92 percent (37) had intercept coefficients which were also significant at the 5 percent level.

Distance.

Interpretation of the coefficients may be explained by referring, for example, to Crown Street NS Keira to Church 1972. Here it may be observed that rent per square foot increased by 0.38 cents with every foot that distance from the PLV point increased. The most striking feature of the list of distance coefficients is the relatively large number which had positive signs - more than 27 percent of all distance coefficients. Of these about 42 percent were not significantly different from zero at the 5 percent level. Conventional land value theory suggests that the distance coefficients will be negative due to the declining desirability of locations further from the PLV site. However, two points brought out previously tend to make this 'principle' less pronounced in the Wollongong core. Firstly the operation of imperfections in the property market, particularly imbalances in bargaining power, may outweight the influence in rent determination due to distance. Secondly, analysis in street block units tends to make each property in the micro unit more homogeneous with respect to distance (i.e. each block may approximate an area of SLD). This is suggested in the fact that about 40 percent of the distance coefficients were not significantly different from zero at the 5 percent level.

Size.

For interpretation of the size coefficients once again refer to street code 2. Here it may be observed that rent per square foot decreased by 0.10 cents with every square foot increase in size. It may also be observed that all of the size coefficients had a negative sign. It is notable that only 18 percent of the coefficients were not significant at the 5 percent level. Furthermore, of the regressions which were significant about 90 percent had significant size coefficients. However, in no instance was the slope of the size plane very great.

Dummy Variable.

Corner influence was estimated by use of a dummy variable.[1] The corner dummy variable coefficient represents the effect of a corner location on rent determination. The value of the variable itself is arbitrarily set at zero for all non-corner locations and one for all corner locations. Although primary interest is in the distance and size variables the coefficients associated with these cannot be properly estimated until the effects of the corner influence have been explicitly removed in the regression analysis. Since, for those sites which are corner locations, the value of the variable is one the value of the coefficient is simply added to, or subtracted from, the equation.

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1. A full discussion of the use of dummy variables can be obtained from Suits, D.B. "Use of Dummy Variables in Regression Equations", Journal of the American Statistical Association, Vol. 52, 1952, pp. 548-559, or, Johnston, J. Econometric Methods, McGraw-Hill Kogakusha Ltd., Tokyo, 1972, pp. 176-186.

For example, in the estimation of rent per square foot in Crown Street NS Keira to Church 1972, the estimated rent is increased by $2.63 for corner locations.

The literature suggests that a corner location will have a positive influence on rents since a corner will be passed by two streams of traffic. However, in Table 6.6 it may be observed that about 32 percent of the coefficients had negative signs although only 21 percent of these were significant at the 5 percent level. In the core of the city a corner location appears to have had a positive significant influence on rent in only 14 percent of the cases over the study period.

Change Over Time.

The change in the coefficients over time is very interesting. Other things being equal, one would expect rents in current terms to increase over time. This would lead to a vertical upwards movement in the rent plane. Table 6.6 shows that all except seven (16 percent) of the intercept coefficients shifted upwards and similarly all but seven of the size coefficients shifted upwards (or remained unchanged). The distance coefficients, however, appeared to move in a completely random fashion. For instance, in Crown Street NS Railway to Keira the coefficient changed sign each succeeding year. In Crown Street NS Kembla to Corrimal the coefficient alternated between increase and decrease in succeeding years. In fact there were only three streets which produced consistent results - a coefficient increase - each year. Certainly at the street block level, as the discussion on correlation coefficients will further verify, there appeared to be a very uncertain

		REGRESSION COEFFICIENTS -		
YEAR	Code	Intercept[1]	Se	Distance[2]
1972	1	+ 725.2	41.5	-0.04^{n}
	2	+ 880.7	53.8	+0.38
	3	+ 886.3	116.1	-0.13^{n}
	4	+1511.8	215	-0.60
	5	+ 965.7	76.5	-0.34
	6	+1247	263.4	-0.92^{n}
	7	+1304	126.6	-0.58
	8	$+ 273.9^{n}$	249.7	$+0.16^{n}$
	9	$+ 365^{n}$	3226	-0.10^{n}
	10	+ 671.2	67.2	-0.48
	11	+ 441.7	49.4	-0.19
	12	+ 522	36.8	-0.25
	13	+ 211.6	25.5	$+0.04^{n}$
1967	1	+ 442.3	25.1	$+0.05^{n}$
	2	+ 642.7	66.3	+0.52
	3	+ 388.8	85.5	+0.31
	4	+ 843.7	222	-0.25
	5	+ 811.7	57.4	-0.37
	6	+ 948.6	196.1	-0.53^{n}
	7	+ 805.1	175.6	-0.28

TABLE 6.6

GROUND FLOOR GENERAL

Se	Size^3	Se	Corner	Se
0.09	−0.06	0.02	−126.3	49.3
0.21	−0.10	0.02	+263.4	90.7
0.12	−0.07	0.01	+258.4	94.4
0.13	−0.08	0.01	+ 96.7^{n}	65.3
0.10	−0.04	0.001	8.9^{n}	85.2
0.81	−0.04^{n}	0.03	+398.7	167.8
0.12	−0.07	0.01	− 63.1^{n}	85.2
0.15	−0.09	0.01	−	−
0.08	−0.01^{n}	0.01	−	−
0.12	−0.02	0.01	− 48.3^{n}	96
0.05	−0.03	0.009	+ 4.1^{n}	20.2
0.06	−0.02	0.005	− 4.6^{n}	58.7
0.03	−0.02	0.006	−	−
0.05	−0.04	0.008	+ 4.42^{n}	29.6
0.30	−0.11	0.03	−178.8^{n}	128.4
0.09	−0.12	0.02	− 1.57^{n}	60.7
0.13	−0.06	0.02	+ 74.8^{n}	77.4
0.08	−0.03	0.007	+ 55.4^{n}	64.3
0.62	−0.03	0.01	+174.5^{n}	162
0.07	−0.04	0.007	− 33.1^{n}	49.9

YEAR	Code	Intercept[1]	Se	Distance[2]
1967	8	+ 56.3^{n}	269.2	+0.21^{n}
	9	+ 386.1	44.7	−0.14
	10	+ 442.9	57.4	−0.25
	11	+ 448.5	31.9	−0.21
	12) 13)	+ 507.5^{n}	459	−0.21^{n}
1962	1	+ 392.8	31.7	−0.08^{n}
	2	+ 386.4	43.2	+0.95
	3	+ 421.3	69.4	+0.16
	4	+1292	255.6	−0.55
	5	+ 650	51.1	−0.17
	6	+ 792.9	235.5	−0.38^{n}
	7	+ 976.8	165	−0.33
	8	+ 304.7	230	+0.01
	9	+ 366	54.4	−0.09^{n}
	10	+ 430.9	42.3	−0.26
	11	+ 428	35.5	−0.25
	12) 13)	+ 420	35.3	−0.22

TABLE 6.6 (cont'd)

Se	Size^3	Se	Corner	Se
0.17	−0.08	0.02	−	−
0.06	−0.01^{n}	0.007	−	−
0.11	−0.004^{n}	0.009	−125.3^{n}	82
0.03	−0.03	0.006	− 2.7^{n}	13
0.27	−0.06^{n}	0.05	− 54.9^{n}	61.2
0.06	−0.02	0.01	+ 80.4	37.8
0.19	−0.10	0.02	−278.4	83.6
0.07	−0.10	0.02	+ 0.90^{n}	46.8
0.15	−0.06	0.02	+102.3^{n}	87.4
0.07	−0.03	0.008	+102.8	55.8
0.75	−0.03^{n}	0.02	+223.5^{n}	195.9
0.08	−0.05	0.01	− 24.1^{n}	49.6
0.14	−0.04	0.01	−	−
0.07	−0.02	0.009	−	−
0.09	−0.04	0.01	−121.0	73.2
0.04	−0.004	0.007	− 47.2	40.2
0.06	−0.02	0.005	+ 32.2^{n}	64.1

YEAR	Code	Intercept[1]	Se	Distance[2]
1958	1	+ 205.5	41.9	+0.03[n]
	2	+ 217.2	33	+0.40
	3	+ 290	62.8	-0.05[n]
	4	+ 534.3	134.2	-0.21
	5	+ 312.9	33.2	-0.05[n]
	6) 7) 8)	+ 353.8	22.6	-0.10
	9	+ 333.7	80.2	-0.07[n]
	10) 11)	+ 166.2	46.9	-0.04[n]
	12) 13)	+ 273.3	80.1	-0.08[n]

1. Vertical axis scale in cents.

2. Feet from the PLV.

3. Square feet.

n. Not significant at the 5 per cent level.

TABLE 6.6 (cont'd)

Se	Size[3]	Se	Corner	Se
0.10	-0.01[n]	0.01	+152.5	46.4
0.15	-0.05	0.02	-118	64.1
0.09	-0.05	0.01	+ 75.0	41.4
0.08	-0.02	0.01	+ 25.6[n]	49.4
0.05	-0.02	0.005	- 59.4[n]	36.7
0.02	-0.03	0.004	+ 23.5[n]	25
0.10	-0.02	0.01	-	-
0.05	-0.02	0.009	+ 38.2[n]	25.2
0.19	-0.03[n]	0.05	-	-

relationship between rent and distance while there appeared to be a very consistent relationship between rent and size. The nuisance variable, corner, for the most part alternated between having a positive and a negative influence on rents. In only two streets, Crown NS Kembla to Corrimal and Crown SS Keira to Church, was there a consistent sign (positive) throughout the study period.

(b) Ground Floor Retail.

Intercept.

With retail use only we are dealing with a more homogeneous set of data therefore we might expect an improvement in the proportion of significant coefficients. The regression coefficients for retail type uses, along with their standard errors, are shown in Table 6.7. Here it may be observed that only 5.6 percent of the intercept coefficients (compared with about 10 percent in the general case) were not significantly different from zero at the 5 percent level of significance

Distance.

Even with this more refined set of data there were a relatively large number - about 24 percent - of the distance coefficients which had positive signs. About 45 percent of these were not significantly different from zero at the 5 percent level. Of the negative coefficients about 28 percent were not significant at the 5 percent level. All in all about 32 percent of the distance coefficients were not significant compared with about 40 percent for the general case.

Size.

Once again all of the size coefficients had a negative sign. Only 11 percent were not significant at the 5 percent level.

REGRESSION COEFFICIENTS -

YEAR	Code	Intercept	Se	Distance
1972	1	+ 731.9	47.4	-0.05^{n}
	2	+ 880.7	53.8	+0.38
	3	+1036.7	108.8	−0.22
	4	+1480.3	240.6	−0.58
	5	+ 990.1	93.1	−0.39
	6	+1256.0	313.6	-0.94^{n}
	7	+1172.6	111.6	−0.48
	8	$+ 261.6^{n}$	277.0	$+0.17^{n}$
	9) 10)	+ 687.4	38.7	−0.42
	11) 12) 13)	+ 654.9	36.0	−0.47
1967	1	+ 438.6	27.3	$+0.04^{n}$
	2	+ 642.7	66.3	+0.52
	3	+ 499.1	115.0	$+0.18^{n}$
	4	+ 859.5	223.6	−0.28
	5	+ 818.5	70.8	−0.38
	6	+1029.8	272.2	-0.75^{n}
	7	+ 794.9	72.8	−0.28

TABLE 6.7

- GROUND FLOOR RETAIL

Se	Size	Se	Corner	Se
0.10	-0.06	0.02	-129.4	53.3
0.21	-0.10	0.02	+263.4	90.7
0.10	-0.14	0.03	- 0.17^{n}	0.11
0.14	-0.08	0.02	+ 57.7^{n}	67.5
0.14	-0.04	0.01	+ 40.2^{n}	106.6
0.94	-0.05^{n}	0.03	+393.4^{n}	444.4
0.11	-0.06	0.01	- 38.7^{n}	76.3
0.17	-0.09	0.02	-	-
0.05	-0.03^{n}	0.02	- 9.5^{n}	41.8
0.06	-0.03	0.005	+ 65.6^{n}	79.1
0.05	-0.04	0.008	+ 9.0^{n}	30.6
0.30	-0.11	0.03	-178.8^{n}	128.4
0.12	-0.12	0.03	- 62.9^{n}	87.7
0.13	-0.06	0.02	+ 72.2^{n}	73.7
0.10	-0.03	0.009	+ 74.3^{n}	81.5
0.70	-0.04	0.02	+125.3^{n}	177.9
0.07	-0.04	0.007	+ 33.8^{n}	47.6

YEAR	Code	Intercept	Se	Distance
1967	8	+1670.5	85.8	-0.81
	9)	+ 518.0	23.4	-0.27
	10)			
	11)			
	12)	+ 457.8	35.8	-0.24
	13)			
1962	1	+ 384.8	32.9	-0.09[n]
	2	+ 386.4	43.2	+0.95
	3	+ 637.2	54.9	-0.04[n]
	4	+1504.2	249.7	-0.66
	5	+ 656.0	52.9	-0.18
	6	+ 804.6	281.2	-0.41[n]
	7	+ 712.1	52.4	-0.26
	8	+ 299.6[n]	255.6	+0.02[n]
	9)	+ 497.8	32.1	-0.26
	10)			
	11)			
	12)	+ 482.4	33.6	-0.29
	13)			

TABLE 6.7 (cont'd)

Se	Size	Se	Corner	Se
0.05	-0.03^{n}	0.02	-	-
0.03	-0.03	0.01	$- 9.7^{n}$	25.3
0.06	-0.03	0.007	$+ 90.8^{n}$	65.7
0.06	-0.02	0.01	+ 89.0	37.1
0.19	-0.10	0.02	-278.4	83.6
0.05	-0.14	0.01	-155.5	38.8
0.14	-0.07	0.02	$+117.7^{n}$	81.1
0.08	-0.03	0.008	-102.8	58.4
0.87	-0.03^{n}	0.03	$+163.3^{n}$	221.9
0.05	-0.03	0.005	$- 13.2^{n}$	31.4
0.15	-0.04	0.01	-	-
0.04	-0.04	0.02	$+ 8.7^{n}$	34.7
0.06	-0.03	0.007	$+ 38.1^{n}$	87.4

YEAR	Code	Intercept	Se	Distance
1958	1	+ 137.4	50.1	+0.26
	2	+ 217.2	33	+0.40
	3	+ 290.0	62.8	-0.05[n]
	4	+ 571.1	137.2	-0.23
	5	+ 312.9	33.2	-0.05[n]
	6)			
	7)	+ 336.5	25.6	-0.09
	8)			
	9)	+ 474.8	69.3	-0.30
	10)			
	11)			
	12)	+ 338.3	32.5	-0.18
	13)			

n. Not significant at the 5 per cent level.

TABLE 6.7 (cont'd)

Se	Size	Se	Corner	Se
0.15	-0.02	0.01	+202.9	48.6
0.15	-0.05	0.02	-118.0	64.1
0.09	-0.05	0.01	+ 75.0	41.4
0.08	-0.02	0.01	+ 17.8[n]	44.6
0.05	-0.02	0.005	- 59.4[n]	36.7
0.03	-0.02	0.005	+ 33.1[n]	26.4
0.09	-0.06	0.03	+104.2[n]	100.5
0.06	-0.21	0.007	-	-

Corner.

Table 6.7 shows that 34 percent of the corner dummy coefficients had a negative sign although 62 percent of these were not significant. All in all about two thirds of these coefficients were not significant at the 5 percent level compared with about 57 percent in the general case.

(iv) First Floor Office.

Intercept.

The regression coefficients for office type use only on the first floor are shown in Table 6.8. Here it may be observed that all of the intercept coefficients were significant at the 5 percent level of significance.

Distance.

Unlike the ground floor coefficients a relatively small proportion of the distance coefficients at the first floor level had a positive sign (14 percent). About 26 percent of the coefficients were not significant at the 5 percent level, but all except 1 of these referred to the same street throughout the period.

Size.

Only 7 percent of the size coefficients were not significant throughout the period. All of the coefficients had a negative sign.

Corner.

The corner dummy variable was not tested at the first floor level since a corner location is of no advantage at this or higher levels.[1]

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1. Display area rather than entrance appears to be the vital factor.

REGRESSION COEFFICIENTS -

YEAR	Code	Intercept	Se
1972	1	+296.7	19.4
	2	+463.9	34.4
	3	+274.9	6.4
	4	+241.5	6.9
1967	1	+234.4	10.5
	2	+324.9	28.5
	3	+213.9	14.0
	4	+231.2	9.3
1962	1	+233.5	16.1
	2	+325.2	29.8
	4	+263.1	4.6
1958	1	+221.9	51.0
	2	+161.6	16.6
	4	+356.2	7.9

n. Not significant at the 5 per cent level.

TABLE 6.8

- FIRST FLOOR OFFICE

Distance	Se	Size	Se
-0.007^{n}	0.02	-0.03	0.005
-0.09	0.03	-0.07	0.01
-0.03	0.01	-0.04	0.005
-0.16	0.02	-0.12	0.01
-0.003^{n}	0.01	-0.02	0.003
-0.07	0.03	-0.04	0.01
-0.06	0.03	-0.004^{n}	0.01
+0.15	0.03	-0.14	0.02
-0.005^{n}	0.02	-0.02	0.004
-0.07	0.03	-0.05	0.01
+0.14	0.01	-0.16	0.008
-0.09^{n}	0.06	-0.03	0.01
-0.04	0.01	-0.03	0.006
-0.01^{n}	0.02	-0.19	0.008

(v) Correlations between Rent, Size and Distance

Some of the most useful results for present purposes are contained in Tables 6.9 and 6.10. Table 6.9 lists the coefficients of skewness for each block in the study area. It may be observed that all of these coefficients are positive. Table 6.10 lists, amongst other things, the partial correlation coefficients between rent and size of space leased. All of these coefficients have a negative sign. It was suggested previously that if equal pressure existed on all rents then one would not expect a per unit rent variation with size of lease. If such a variation existed then certain inferences could be drawn. Now, if the distribution of EFSS has a positive skew, and if there is a negative correlation between rent and size, then this suggests one of the following situations exists: either the distributions of TOFSR and EFSS have the same skew, and a one tenant-unit vacancy has occurred across the board; or the distribution of TOFSR is more highly skewed than the distribution of EFSS (the modal class of the demand distribution lies below the modal class of the supply distribution).[1] As suggested earlier the first case is rather extreme and therefore the second case represents the more likely situation.[2] In this LMD situation the USC landlords are in a relatively worse bargaining position than LSC landlords. That is, the bargaining power of the tenant tends to increase as size of space leased increases. Looking only at those street blocks where there were significant regressions it may be observed that there were only four

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1. The other two LMD cases are eliminated since they both require the distribution of EFSS to have a negative skew.

2. It may similarly be suggested that a negative skew in the distribution of EFSS, coupled with a positive correlation between per unit rents and size of lease would generally tend to indicate that the distribution of TOFSR is more highly skewed. In this situation (UMD) USC landlords are in a relatively better bargaining position than LSC landlords.

instances where there were no significant correlation between rent and size.

The correlations between rent and distance, also shown in Table 6.10, tend to substantiate the earlier suggestion that the operation of the size of lease and special accessibility factors may disrupt any correlations between rent and distance. Of the 37 blocks which had significant regressions, 18 had insignificant correlations between rent and distance. Furthermore, one of the rent/distance correlations was significantly positve at the 5 percent level.

If there was a positive correlation between distance and size then operation of the general accessibility factor would lead to a negative correlation between rent and size. To check that this has not happened a correlation analysis between distance and size was carried out. These results are also shown in Table 6.10. In only six cases where there was a significant correlation between rent and size was there also a significant correlation between distance and size. One of these cases occurred where there was not a significant regression.

It is interesting to compare these and earlier results with the results listed in Tables 6.11, 6.12, 6.13 and 6.14. Table 6.11 shows the results obtained when only retail data was used in the correlations. (Table 6.12 indicates that the coefficients of skewness were all positive). In those blocks which had significant regressions only 4 did not have significant correlations between rent and size while 19 did not have significant correlations between rent and distance. In only 4 cases where there was a significant correlation between rent and size was there also a significant correlation between distance and size. Table 6.13 lists the partial correlation coefficients obtained using first

TABLE 6.9

PEARSON'S SECOND COEFFICIENT OF SKEWNESS - GROUND FLOOR

YEAR	Street Code	Mean Size[1]	Standard Deviation[1]	Median Size[1]	Coefficient of Skewness
1972	1	1323	1376	920	+0.88
	2	1997	1275	1870	+0.30
	3	1278	1280	923	+0.83
	4	1316	1394	842	+1.01
	5	3054	3821	1570	+1.16
	6	2476	2927	1680	+0.82
	7	1870	1900	1150	+1.14
	8	1008	990	715	+0.90
	9	3495	4044	2008	+1.10
	10	2114	2435	1454	+0.81
	11	1487	971	1100	+1.19
	12	7476	1185	4160	+0.84
	13	2688	3811	975	+1.35
1967	1	1537	1703	911	+1.10
	2	1674	1187	1350	+0.82
	3	1092	901	817	+0.91
	4	1073	1221	725	+0.86
	5	3033	3829	1540	+1.17
	6	2653	3018	1950	+0.70
	7	1870	1900	1150	+1.14
	8	1284	793	930	+1.16
	9	3362	4426	1390	+1.34
	10	2112	2515	1450	+0.80
	11	1435	998	900	+1.61
	12	2581	3651	975	+1.32
	13	2528	1251	2138	+0.94
1962	1	1598	1786	950	+1.09
	2	1674	1187	1350	+0.82
	3	1059	836	677	+1.37
	4	1097	1245	750	+0.84
	5	2804	3013	1555	+1.24
	6	2684	3014	2050	+0.63
	7	2306	2008	1876	+0.64
	8	1008	990	713	+0.90
	9	3401	4442	1390	+1.36
	10	2112	2515	1450	+0.80
	11	1435	998	900	+1.61
	12	2687	3775	963	+1.37
	13	2374	1229	2000	+0.91
1958	1	1678	2111	650	+1.48
	2	1592	896	1350	+0.81
	3	1234	840	840	+1.41
	4	1007	1207	725	+0.70
	5	2957	3100	1610	+1.30
	6)				
	7)	1859	1551	971	+1.72
	8)				

TABLE 6.9 (cont'd)

YEAR	Street Code	Mean Size[1]	Standard Deviation[1]	Median Size[1]	Coefficient of Skewness
1958	9	2963	4145	1420	+1.12
	10	1353	509	1200	+0.90
	11	1771	979	1525	+0.75
	12) 13)	2592	2605	1482	+1.28

1. Square feet of floor space.

TABLE 6 .10

PARTIAL CORRELATION COEFFICIENTS[1] - GROUND FLOOR

YEAR	Street Code	Rent and Size	Rent and Distance	Distance and Size	Significance[2] 1%	Significance[2] 5%
1972	1	-0.53	-0.32	+0.63	0.45	0.35
	2	-0.70	+0.11	+0.34	0.62	0.50
	3	-0.60	-0.37	+0.04	0.46	0.36
	4	-0.46	-0.48	-0.32	0.53	0.41
	5	-0.53	-0.43	-0.11	0.49	0.38
	6	-0.42	-0.42	-0.45	0.61	0.48
	7	-0.52	-0.42	-0.31	0.47	0.37
	8	-0.87	+0.11	+0.04	0.59	0.47
	9	-0.51	-0.55	+0.39	0.59	0.47
	10	-0.15	-0.63	-0.37	0.59	0.47
	11	-0.77	-0.80	+0.42	0.66	0.53
	12	-0.58	-0.68	+0.35	0.45	0.35
	13	-0.76	+0.23	+0.12	0.71	0.58
1967	1	-0.71	-0.19	+0.45	0.44	0.34
	2	-0.61	-0.08	+0.43	0.55	0.43
	3	-0.68	+0.38	+0.04	0.44	0.34
	4	-0.52	-0.13	-0.34	0.52	0.40
	5	-0.48	-0.55	-0.11	0.49	0.38
	6	-0.49	-0.33	-0.14	0.62	0.50
	7	-0.59	-0.34	-0.31	0.47	0.37
	8	-0.81	+0.14	+0.11	0.59	0.47
	9	-0.59	-0.66	+0.39	0.64	0.51
	10	-0.14	-0.54	-0.38	0.61	0.48
	11	-0.79	-0.83	+0.39	0.68	0.55
	12	-0.59	-0.44	+0.17	0.45	0.35
	13	-0.67	-0.62	+0.51	0.76	0.63
1962	1	-0.58	-0.50	+0.52	0.45	0.35
	2	-0.35	+0.34	+0.43	0.55	0.43
	3	-0.74	+0.31	-0.03	0.46	0.36
	4	-0.30	-0.47	-0.33	0.53	0.41
	5	-0.51	-0.36	-0.17	0.50	0.39
	6	-0.38	-0.30	-0.12	0.62	0.50
	7	-0.62	-0.51	-0.10	0.53	0.41
	8	-0.64	-0.56	+0.04	0.59	0.47
	9	-0.63	-0.51	+0.38	0.64	0.51
	10	-0.16	-0.59	-0.38	0.61	0.48
	11	-0.80	-0.84	+0.34	0.68	0.55
	12	-0.55	-0.58	+0.17	0.48	0.37
	13	-0.67	-0.61	+0.49	0.80	0.67
1958	1	-0.44	-0.50	+0.68	0.53	0.41
	2	-0.18	+0.28	+0.45	0.55	0.43
	3	-0.79	-0.27	+0.39	0.59	0.47
	4	-0.20	-0.45	-0.28	0.54	0.42
	5	-0.58	-0.16	-0.12	0.52	0.40
	6)					
	7)	-0.69	-0.48	-0.29	0.43	0.33
	8)					

TABLE 6.10 (cont'd)

YEAR	Street Code	Rent and Size	Rent and Distance	Distance and Size	Significance[2] 1%	Significance[2] 5%
1958	9	-0.54	-0.34	+0.22	0.71	0.58
	10	-0.54	-0.53	+0.17	0.64	0.51
	11	-0.76	-0.35	+0.32	0.76	0.63
	12) 13)	-0.74	-0.70	+0.51	0.44	0.34

1. We can suppose that the Wollongong CBD is but a sample from the entire population of CBD's. In that case the assumption of bivariate normality is not violated. Even if the supposition regarding the sample is not adopted, tests using the Kendall rank correlation coefficient, τ, showed that a large majority of correlations between rent and size were significant.

2. Source: Fisher, R.A. and Yates, F. Statistical Tables for Biological, Agricultural and Medical Research, Hafner Publishing Co., New York, 1957, Table VII.

TABLE 6.11

PARTIAL CORRELATION COEFFICIENTS - RETAIL ONLY - GROUND FLOOR

YEAR	Street Code	Rent and Size	Rent and Distance	Distance and Size	Significance[1] 1%	Significance[1] 5%
1972	1	-0.53	-0.29	+0.58	0.47	0.37
	2	-0.70	+0.11	+0.34	0.62	0.50
	3	-0.61	-0.11	-0.33	0.50	0.39
	4	-0.57	-0.35	-0.39	0.56	0.44
	5	-0.55	-0.31	-0.11	0.57	0.40
	6	-0.53	-0.39	-0.21	0.62	0.50
	7	-0.67	-0.49	-0.28	0.50	0.39
	8	-0.87	+0.15	-0.001	0.62	0.50
	9) 10) 11)	-0.50	-0.93	+0.40	0.55	0.43
	12) 13)	-0.51	-0.67	-0.14	0.50	0.39
1967	1	-0.73	-0.20	+0.41	0.46	0.36
	2	-0.61	-0.08	+0.43	0.55	0.43
	3	-0.69	+0.37	-0.15	0.46	0.36
	4	-0.54	-0.13	-0.37	0.57	0.46
	5	-0.51	-0.67	-0.11	0.51	0.40
	6	-0.57	-0.31	+0.12	0.64	0.51
	7	-0.65	-0.30	-0.28	0.50	0.39
	8	-0.98	-0.12	+0.09	0.62	0.50
	9) 10) 11)	-0.57	-0.93	+0.36	0.56	0.44
	12) 13)	-0.60	-0.51	+0.03	0.50	0.39
1962	1	-0.51	-0.50	+0.45	0.47	0.37
	2	-0.35	+0.34	+0.43	0.55	0.43
	3	-0.86	+0.31	-0.24	0.47	0.37
	4	-0.30	-0.55	-0.36	0.56	0.44
	5	-0.56	-0.48	-0.17	0.52	0.40
	6	-0.45	-0.28	+0.12	0.64	0.51
	7	-0.71	-0.49	-0.12	0.59	0.47
	8	-0.63	+0.02	-0.001	0.62	0.50
	9) 10) 11)	-0.59	-0.88	+0.36	0.56	0.44
	12) 13)	-0.57	-0.61	+0.02	0.50	0.39
1958	1	-0.38	-0.41	+0.68	0.54	0.42
	2	-0.18	+0.28	+0.45	0.55	0.43
	3	-0.79	-0.27	+0.39	0.59	0.47
	4	-0.17	-0.49	-0.36	0.56	0.44
	5	-0.64	-0.23	-0.14	0.55	0.43
	6) 7) 8)	-0.69	-0.49	+0.01	0.55	0.43

TABLE 6.11 (cont'd)

YEAR	Street Code	Rent and Size	Rent and Distance	Distance and Size	Significance[1] 1%	Significance[1] 5%
1958	9) 10) 11)	-0.57	-0.72	+0.34	0.62	0.50
	12) 13)	-0.49	-0.51	+0.02	0.50	0.39

1. Source: Fisher and Yates, op.cit.

TABLE 6.12

PEARSON'S SECOND COEFFICIENT OF SKEWNESS - RETAIL ONLY - GROUND FLOOR

YEAR	Street Code	Mean Size[c]	Standard Deviation[c]	Median Size[c]	Coefficient of Skewness
1972	1	1218	1376	775	+0.97
	2	1997	1275	1870	+0.30
	3	981	687	884	+0.42
	4	1297	1438	827	+0.98
	5	3142	3860	1540	+1.25
	6	2478	2930	1680	+0.82
	7	1849	1932	1044	+1.25
	8	1090	1033	752	+0.98
	9) 10) 11)	1375	836	1000	+1.34
	12) 13)	2152	3053	950	+1.18
1967	1	1470	1750	780	+1.18
	2	1674	1187	1350	+0.82
	3	962	819	664	+1.09
	4	1024	1231	700	+0.79
	5	3142	3860	1540	+1.25
	6	2669	3100	1450	+1.18
	7	1849	1932	1044	+1.25
	8	1161	1074	754	+1.14
	9) 10) 11)	1338	843	1000	+1.20
	12) 13)	1810	2522	800	+1.20
1962	1	1492	1788	821	+1.13
	2	1674	1187	1350	+0.82
	3	943	722	650	+1.22
	4	1049	1260	725	+0.77
	5	2695	3500	1350	+1.15
	6	2669	3100	1450	+1.18
	7	2289	2086	1876	+0.59
	8	1090	1033	752	+0.98
	9) 10) 11)	1338	843	1000	+1.20
	12) 13)	1753	2272	863	+1.18
1958	1	1542	2055	645	+1.31
	2	1592	896	1350	+0.81
	3	1234	840	840	+1.41
	4	1049	1260	725	+0.77
	5	2900	3215	1560	+1.25
	6) 7) 8)	2550	1993	2119	+0.65

TABLE 6.12 (cont'd)

YEAR	Street Code	Mean Size[c]	Standard Deviation[c]	Median Size[c]	Coefficient of Skewness
1958	9) 10) 11)	1390	760	1150	+0.95
	12) 13)	1753	2272	863	+1.18

c. Square feet.

TABLE 6.13

PARTIAL CORRELATION COEFFICIENTS - FIRST FLOOR[1]

YEAR	Street Code	Rent and Size	Rent and Distance	Distance and Size	Significance[2] 1%	Significance[2] 5%
1972	1	-0.77	+0.12	-0.22	0.55	0.43
	2	-0.70	-0.32	-0.18	0.53	0.41
	3	-0.91	-0.48	+0.30	0.64	0.51
	4	-0.55	+0.07	+0.76	0.56	0.44
1967	1	-0.89	+0.22	-0.28	0.55	0.43
	2	-0.63	-0.39	-0.07	0.52	0.40
	3	-0.12	-0.50	+0.24	0.66	0.53
	4	-0.71	-0.15	+0.76	0.56	0.44
1962	1	-0.83	+0.18	-0.27	0.59	0.47
	2	-0.70	-0.30	-0.14	0.56	0.44
	4	-0.87	-0.35	+0.76	0.56	0.44
1958	1	-0.50	-0.24	-0.30	0.68	0.55
	2	-0.63	-0.38	-0.21	0.59	0.47
	4	-0.98	-0.37	+0.35	0.57	0.46

1. Office use only.

2. Fisher and Yates, op.cit.

floor office type use data. It may be observed that all of the coefficients had a negative sign. From Table 6.14 it can be seen that the coefficients of skewness are all positive. Based on earlier discussion this LMD case is one in which the distribution of TOFSR is more highly skewed than that of EFSS. In those blocks which had significant regressions all also had significant correlations between rent and size. In only 3 cases was there a significant correlation between distance and size. It is hardly surprising that there were no significant correlations between rent and distance since passing trade is of little importance to upper floor tenants.

TABLE 6.14

PEARSON'S SECOND COEFFICIENT OF SKEWNESS - FIRST FLOOR[1]

YEAR	Street Code	Mean Size	Standard Deviation	Median Size	Coefficient of Skewness
1972	1	1588	1320	1300	+0.65
	2	2040	624	1900	+0.67
	3	990	414	926	+0.46
	4	641	328	586	+0.51
1967	1	1556	1317	1300	+0.58
	2	1992	673	1900	+0.41
	3	962	421	895	+0.48
	4	641	328	586	+0.51
1962	1	1735	1398	1350	+0.83
	2	2047	631	1900	+0.70
	4	641	328	586	+0.51
1958	1	1923	1649	1300	+1.13
	2	2095	650	1900	+0.90
	4	590	229	583	+0.09

1. Office type use only.

(vi) Other Hypotheses

Another hypothesis suggested was that the decrease in the volume of passing trade as distance from the PLV site increased would lead to a decrease in the relative difference between ground and upper floor rentals. This was tested in two randomly selected areas, the northside of Crown Street between Keira and Kembla Streets and the west side of Keira Street between Crown and Flinders Streets. Table 6.15 indicated that there was a significant correlation between the ground/first floor rent ratio and distance in 1972 and 1967 but not in the two earlier years.

A test of the hypothesis that rent would decrease with elevation due to the declining importance of passing trade to upper floor tenants is shown in Table 6.16. Here the per unit rental on each floor in buildings with more than four storeys was calculated. This shows that there was a decline in per unit rental with height above ground.

The importance of corner influence in reducing the total variation is shown by the results in Table 6.17. Here the regressions were run with and without the corner dummy variable. Of the 33 regressions which were both significant and in which the blocks had a corner business facing the relevant street, 31 showed a reduction in unexplained variation after the addition of the corner dummy variable.

6.5 Conclusion

The empirical analyses presented in Chapter three and in the latter part of the present chapter suggests that 'conventional' (that is, spatial) land value theory fails to explain the determination of rents (either land or floor space) in street block submarkets (discussed in chapter five). It was suggested that such street blocks

TABLE 6.15

CORRELATION ANALYSIS BETWEEN G/F.[1] AND D[2]

YEAR	Street Code	Correlation Coefficients	Significance 1%	5%
1972	2, 3	-0.77	0.56	0.44
	10, 11	-0.69	0.59	0.47
1967	2, 3	-0.48	0.55	0.43
	10, 11	-0.61	0.61	0.48
1962	2, 3	-0.08	0.55	0.43
	10, 11	-0.36	0.62	0.50
1958	2, 3	-0.27	0.57	0.46
	10, 11	-0.40	0.71	0.58

1. Ground floor/First floor rent ratio.

2. Distance between plv site and site in question.

TABLE 6.16

RENT VARIATION WITH HEIGHT ABOVE GROUND[1]

YEAR	Floor Level	Rent Per Square Foot($)
1958	Ground (G)	2.74
	First (Fi)	2.01
	Second (S)	1.76
	Third (T)	1.76
	Fourth (Fo)	1.77
1962	G	3.32
	Fi	2.28
	S	2.28
	T	2.28
	Fo	2.27
1967	G	5.31
	Fi	2.26
	S	2.24
	T	2.24
	Fo	2.20
1972	G	6.11
	Fi	2.57
	S	2.56
	T	2.56
	Fo[2]	2.52

1. Information was not available on the Transport and General Insurance Building and the Iron Workers' Club Building when this table was constructed. This information was available later and has been included elsewhere in the thesis.

2. Since the CML Building was the only building with more than five levels above ground level, storeys five and six were excluded.

TABLE 6.17

IMPROVEMENT IN EXPLAINED VARIATION BROUGHT ABOUT BY THE ADDITION OF VARIABLES - GROUND FLOOR

YEAR	Street Code	Distance Variable(D) D	Size Variable(S) D+S	Corner Dummy(C) D+S+C	R^2
1972	1	0.10	0.30	0.45	0.45
	2	0.08	0.79	0.86	0.86
	3	0.03	0.59	0.61	0.61
	4	0.12	0.61	0.69	0.69
	5	0.18	0.52	0.52	0.52
	6	0.18	0.40	0.59	0.59
	7	0.18	0.64	0.66	0.66
	8	0.01	0.77	f	0.77
	9	0.30	0.41	f	0.46
	10	0.38	0.56	0.66	0.66
	11	0.62	0.86	0.86	0.86
	12	0.45	0.59	0.62	0.62
	13	0.23	0.69	f	0.69
1967	1	0.04	0.52	0.53	0.53
	2	0.01	0.46	0.48	0.48
	3	0.14	0.59	0.62	0.62
	4	0.02	0.39	0.40	0.40
	5	0.30	0.59	0.61	0.61
	6	0.11	0.40	0.46	0.46
	7	0.12	0.64	0.71	0.71
	8	0.02	0.71	f	0.71
	9	0.44	0.58	f	0.58
	10	0.29	0.30	0.42	0.42
	11	0.69	0.94	0.94	0.94
	12) 13)	0.28	0.51	0.52	0.52
1962	1	0.25	0.36	0.45	0.45
	2	0.12	0.65	0.66	0.66
	3	0.10	0.60	0.62	0.62
	4	0.22	0.49	0.49	0.49
	5	0.13	0.48	0.55	0.55
	6	0.09	0.27	0.35	0.35
	7	0.26	0.72	0.76	0.76
	8	0.004	0.41	f	0.41
	9	0.26	0.48	f	0.48
	.0	0.35	0.51	0.53	0.53
	.1	0.71	0.90	0.90	0.90
	.2) .3)	0.35	0.53	0.56	0.56
1958	1	0.25	0.53	0.55	0.55
	2	0.08	0.33	0.34	0.34
	3	0.07	0.70	0.71	0.71
	4	0.20	0.34	0.34	0.34
	5	0.03	0.38	0.46	0.46
	6) 7) 8)	0.23	0.72	0.74	0.74

TABLE 6.17 (cont'd)

YEAR	Street Code	Distance Variable(D) D	Size Variable(S) D+S	Corner Dummy(C) D+S+C	R^2
1958	9	0.12	0.34	0.34	0.34
	10) 11)	0.11	0.60	0.61	0.61
	12) 13)	0.49	0.53	0.53	0.53

f. No corner land use with a frontage in the relevant street.

were areas of similar locational desire (SLD). If such was the case then a variation in per unit rents with distance from the PLV within the area of SLD would not be expected. The evidence indicated that there appeared to be little relationship between per unit rents and location within the SLD areas. It was suggested, then (see Chapter three), that any variation in per unit rents within SLD areas would be due to non spatial market forces.

The fact that floor space offered for sale is not homogeneous with respect to size[1] presented the opportunity to build the bargaining model of the present chapter. Bargaining was considered solely in terms of the supply/demand interrelationship - the existence of excess supply[2] indicated a bargaining power structure in favour of the tenant. It was hypothesised that bargaining power (and consequently per unit rents) increased or decreased as vacancy rates increased or decreased. Application of the model in the Wollongong CBD appeared to provide a suitable explanation for rent behaviour there.

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1. Nor quality, nor age etc., but these factors were ignored.
2. Above what may have been considered 'normal' or 'expected'.

CHAPTER 7

BARGAINING POWER, LOCATION AND REVENUE DETERMINATION

7.1 Introductory Statement

In the previous chapter the discussion was concerned with the manner in which floor space rents may vary as bargaining power between landlord and tenant varies. The model relied on the emergence of a 'shock' in the form of vacancies. The present chapter builds upon this and moves a step closer to analysis of the problem of capital/land substitution. Specifically the discussion examines the question of revenue determination in a given building. Here this is taken to be basically a question of the relationship between revenue variation and output variation under differing assumptions of a land factor input. For different conditions of relative bargaining strength the land size is assumed fixed so that output variations can only take place on the vertical plane. It will be shown in a later chapter that this is not a particularly strong assumption in the analysis.

The discussion is presented in four stages. Section 7.2 establishes, in functional form, a rent variation model. Having been thus established the behaviour of the model under differing assumptions of bargaining power and location is then analysed. This analysis is primarily aimed at ascertaining the influence of bargaining power and location on the height and slope of the function.

Section 7.3 utilizes the available empirical information to undertake a series of statistical tests associated with the model. The data, via these tests, lend support to the model.

Given the particular functional form for average rent established in the first section, section 7.4 builds a total revenue function which is utilised for analysis of profit variation in later chapters. Again the analysis examines the variation in the behaviour of the total revenue function (height and slope) under differing assumptions of bargaining power and location.

Finally, section 7.5 introduces the concept of the rate of capitalisation into the analysis in order that the total revenue function may be restated as a total value (present value) function.

7.2 The Average Rent Function

(i) Vertical Variation in Rent

The manner in which floor space rentals vary with height above ground depends on a variety of factors. For instance, in Vancouver upper floor rentals in the CBD are greater than those on the lower floors due to the prestige associated with upper floor locations. In Sydney and Melbourne upper floor rentals are often greater than lower floor rentals due to scenic attraction.[1] Higher rentals are also obtainable on the upper floors in New York's Manhattan district.[2]

However the author has found that in Wollongong the per unit floor space rentals on the lower floors are greater than those obtainable on the upper floors (since accessibility to passing trade is of relatively minor importance to upper floor tenants). It has been assumed that for all tenants, other things being equal, demand for floor space is a direct function of general accessibility, while for some tenants it is

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1. Pointed out to the author by a number of discussants of his paper entitled "The Market for Commercial Floor Space in Wollongong - The Determination of the Pattern of Contract Rents", presented at the Fourth Conference of Economists of Australia and New Zealand, Canberra, 1974.

2. Klaber, E. H. "The Skyscraper: Boon or Bane?", Journal of Land and Public Utility Economics, Vol. 6, No. 4, 1930, p. 356.

also a direct function of ground floor (special) accessibility. Now, although accessibility to passing trade decreases as height increases the general accessibility factor will remain constant as height increases. Therefore, although the influence of special accessibility may decline to zero as height increases, general accessibility will, ceteris paribus, continue to exert a positive, constant influence.

This decrease in per unit rentals on the upper floors implies that there is an average rent curve[1] which intersects the vertical (rent) axis and decreases at a decreasing rate towards an asymptotic level determined by the constant rent obtainable on the upper floors. An example of this is shown in Table 7.1 using market data for a seven storey building and assuming truncation of varying heights. This

TABLE 7.1

AVERAGE RENT VARIATION, CML BUILDING, 1972[a]

Floor level	Rent psf $ on each floor	Average Rent psf of total floor space $
Ground	8.14	8.14
1st	3.21	5.96
2nd	3.00	4.81
3rd	3.00	4.30
4th	3.00	4.02
5th	3.00	3.84
6th	3.00	3.71

a. Source: Owner Return Files, Valuer General Records, Wollongong.

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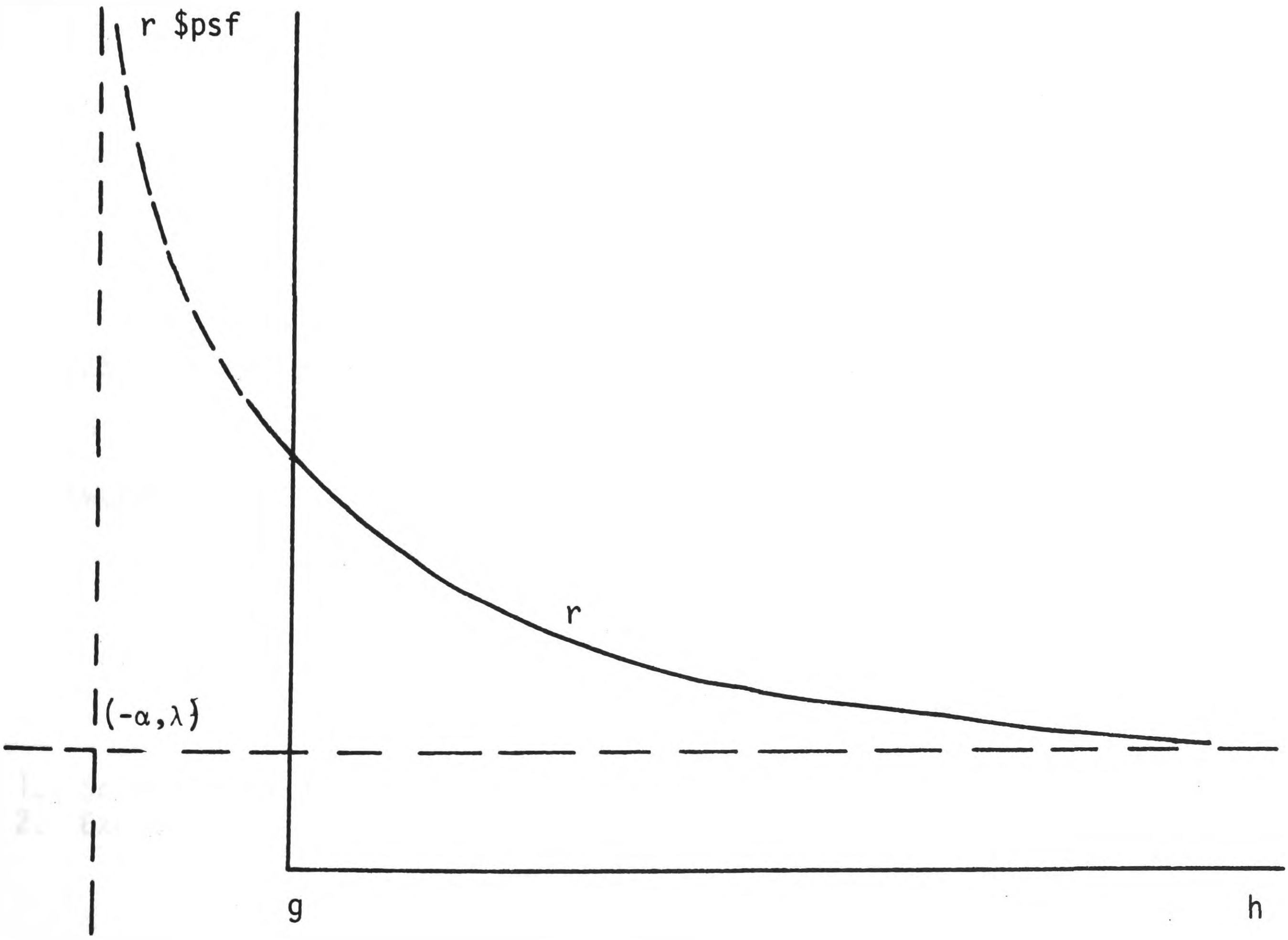
1. Average rent per square foot of total floor space.

behaviour of average rent may be represented diagrammatically by a rectangular hyperbola whose vertical axis is displaced to the left of the rent/height origin and whose horizontal axis lies above the rent/height axis as in Figure 7.1. The curve is defined only for positive rents and positive heights (basement and other lower floors are excluded from the analysis). The average rent function may therefore, in such conditions, be expressed as:[1]

$$r = \frac{\beta}{h + \alpha} + \lambda \qquad 7.1$$

Figure 7.1



1. The use of this, and other functional forms, in economic analysis is discussed in Allen, R.G.D. Mathematical Analysis for Economists, Macmillan, London, 1972.

where: r = average rent per square foot of total floor space; let q = the total quantity of floor space in the building and θ = the quantity of floor space on each floor. Then $q = \Sigma\theta_i$. If θ is assumed to be a constant then $q = h\theta$ where h = the number of floors, hence h may be defined simply as q/θ. (Table 7.2 indicates that in Wollongong this is a relatively weak assumption. In only one of the five buildings with more than five storeys was the standard deviation as a proportion of mean floor space size exceptionally large); β determines the shape of the curve and is itself determined by the special accessibility factor related to ground floor location;[1] λ = the constant (minimum) rent obtainable on the upper floors. The asymptotes are given by $r = \lambda$ and $h = -\alpha$.

TABLE 7.2

VARIATION IN FLOOR SPACE SIZES[1]

Building	Code	No. of Storeys[2]	Mean Size Per Floor (μ) (sq.ft.)	SD (sq.ft.)	SD as ppt of mean
T & G	1	6	3933	151	0.04
Ironworkers	2	5	4575	321	0.07
CML	3	7	3522	442	0.13
MLC	4	5	1414	43	0.03
AMP	5	5	5996	1668	0.28

1. Source: Owner Return Files, Valuer General Records, Wollongong.
2. Excluding basement and lower floors.

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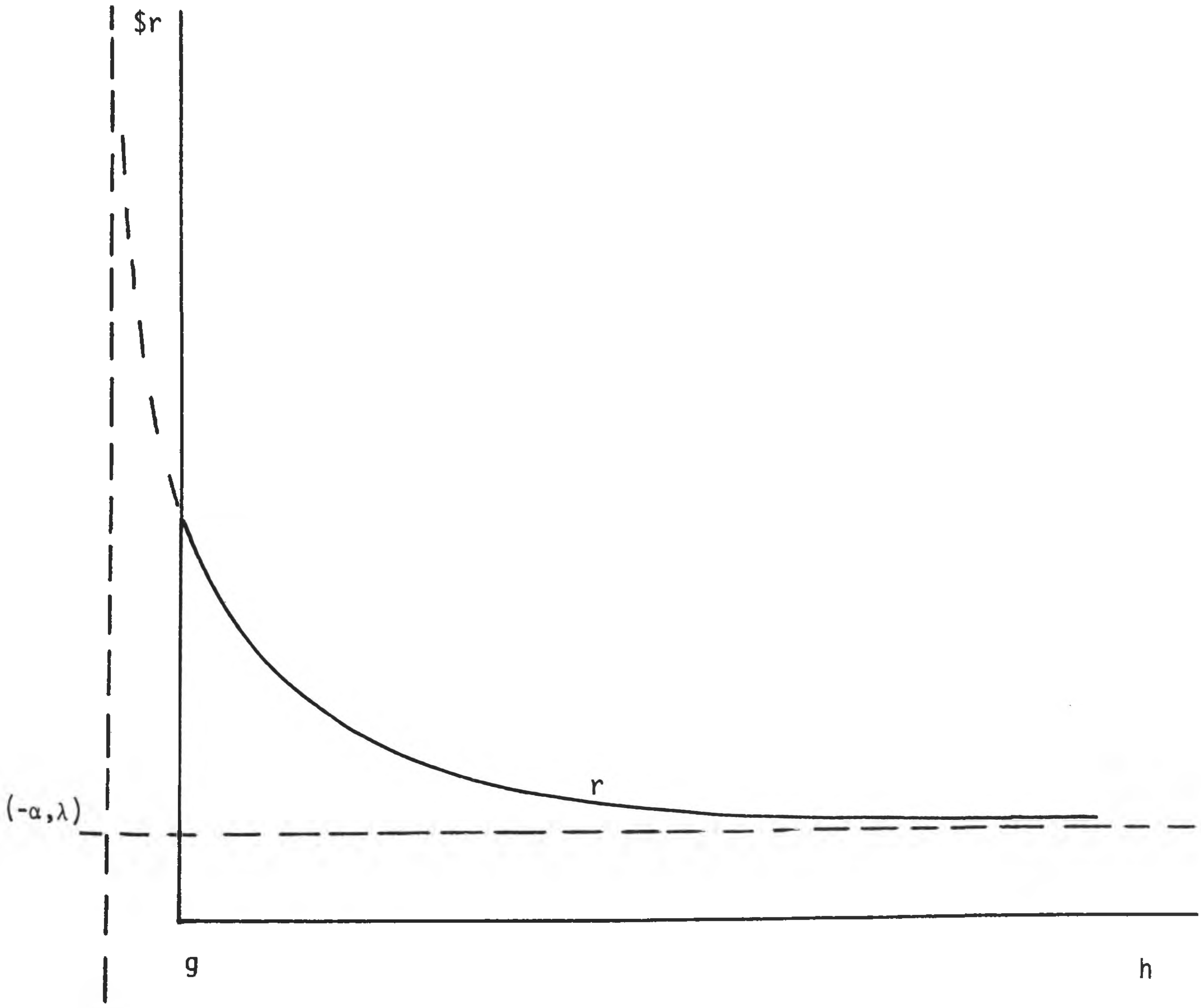
1. Cf. Allen, op.cit., p. 115 regarding shape.

The distance the vertical asymptote, $-\alpha$, lies to the left of origin is determined by the special accessibility factor related to ground floor location. For example, suppose the special accessibility factor determines that there is a relatively low cross elasticity of demand between ground and upper floors. If there is a need to preserve this relationship under changing conditions then the resulting difference between ground and upper floors will imply that the axes of the average rent function will lie close to the rent/height origin and average rent will initially decline relatively steeply between ground and upper floors (Figure 7.2). The height of the horizontal asymptote, λ, is determined by the minimum (constant) per unit rent obtained on the upper floors.

Figure 7.2

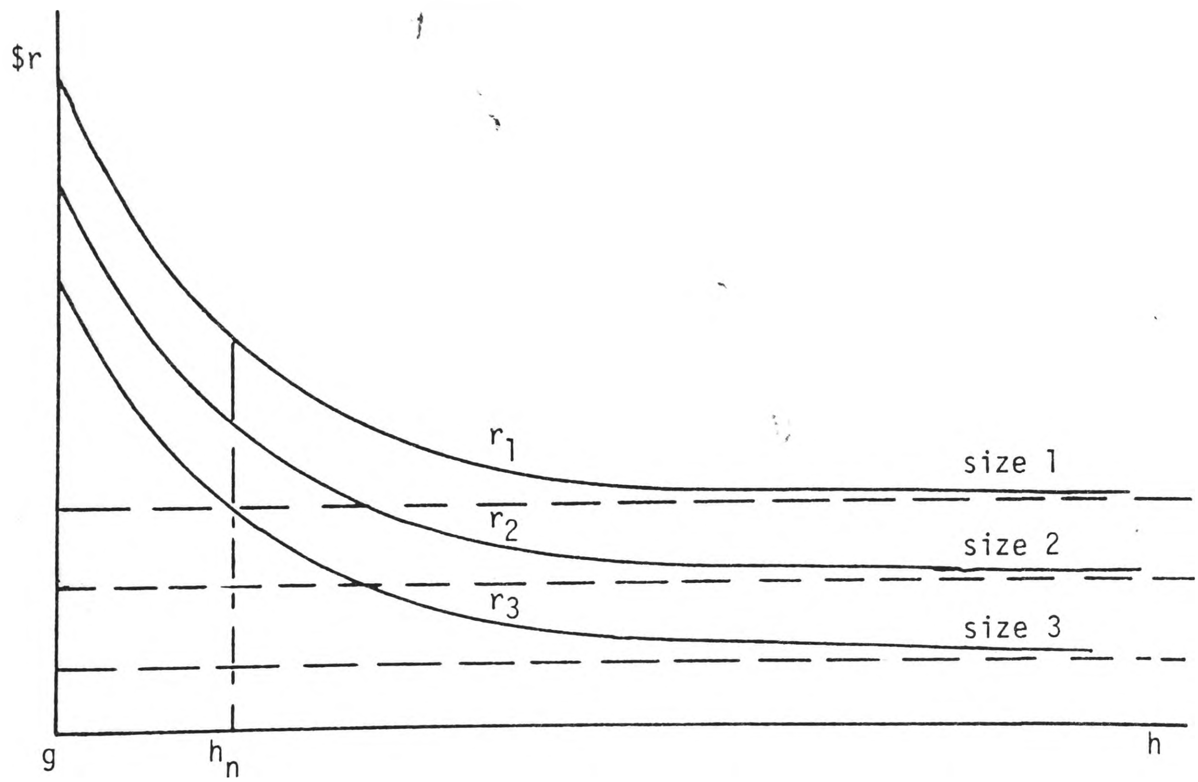


The average rent function represents the average rent per square foot of total floor space a landlord/developer may expect to receive, ceteris paribus, if he constructs a building of a given height.

(ii) Movement of the Average Rent Function

Given these assumptions how may the average rent function be expected to behave under varying conditions? Consider first the case where the distributions of TOFSR and EFSS are such that an LMD situation exists. It has been demonstrated that in this situation the per unit floor space rental will decrease as the size category increases.[1] If it is assumed that there is no variation in size distribution vertically throughout a building then, as size category increases, the entire average rent function will be shifted downwards towards a new horizontal asymptote determined by the new minimum rental as shown in Figure 7.3. Since the relative difference between ground and upper floor rentals will be preserved so that:

Figure 7.3



1. See Chapter 6 above.

$$\frac{\partial r_1}{\partial h} = \frac{\partial r_2}{\partial h} = \frac{\partial r_3}{\partial h} \quad . \ . \ . = \frac{\partial r_n}{\partial h}$$ where 1, 2 ... n denotes increasing size categories

where

$$\frac{\partial r}{\partial h} = - \frac{\beta}{(h + \alpha)^2}$$

then α will also decrease. In Figure 7.3 at any height, h_n, a lower average rent is obtained as the size category increases. For example, suppose at h_n the size category was increased from 4 x 2400 square feet per floor to 1 x 10,000 square feet per floor (the difference being lost in dividing walls, access ways, facilities etc.) e.g. size 1 to size 3 (throughout the entire building). This would result in a lower per unit, and hence lower average, rent being obtained - from r_1 to r_3. If the opposite condition prevails and a UMD situation exists then the opposite effect will take place - as the size category increases the average rent function will shift upwards.

Now, allow the location to vary so that the force of general accessibility may come into operation.[1] It has been shown previously that per unit rentals within a given size category will decrease with distance from the PLV site. It has also been suggested that the relative difference between ground and upper floor rentals will decline with distance from the PLV site since ground floor rentals decrease at a greater rate than upper floor rentals. How will this effect the average rent function?

Consider the variation with distance in a given size category.[2] Since the per unit rental decreases on every floor the average rent

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1. That is, a variation from one SLD area to another.

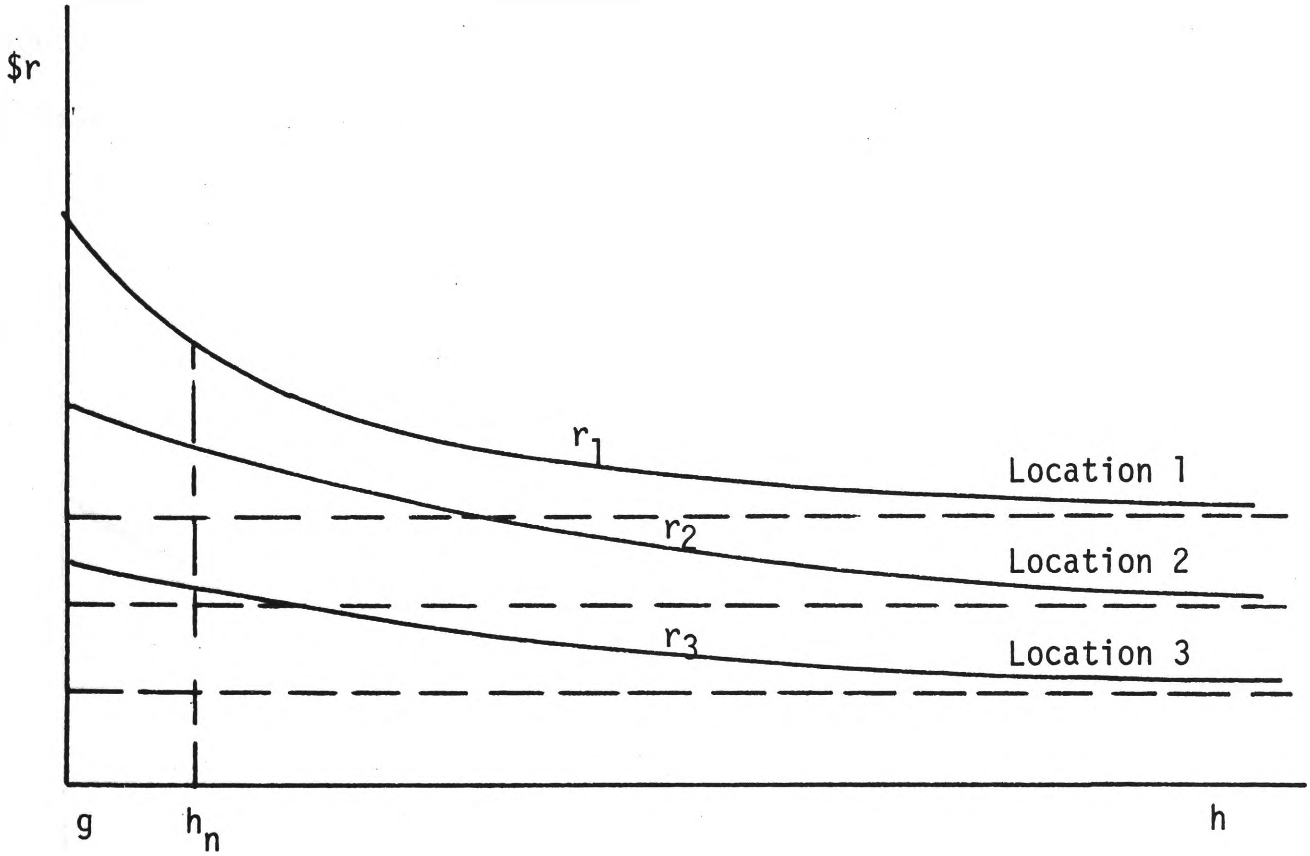
2. Again, we are considering variation from one SLD area to another (SLD areas increasingly distant from the PLV site).

function is lowered, that is, the horizontal asymptote is shifted downwards. Simultaneously, since the relative difference between ground and upper floor rentals decreases, the shape of the curve changes, and the entire curve is shifted to the left, that is, the value of both α and β decreases. The whole process implies a lowering and a 'flattening' of the curve as shown in Figure 7.4. Here, at any height, h_n,

$$\frac{\partial r_1}{\partial h} > \frac{\partial r_2}{\partial h} > \frac{\partial r_3}{\partial h} \quad . \; . \; . > \frac{\partial r_n}{\partial h} \qquad 7.3$$

where 1, 2 ... n denotes locations in SLD areas increasingly distant from the PLV site.

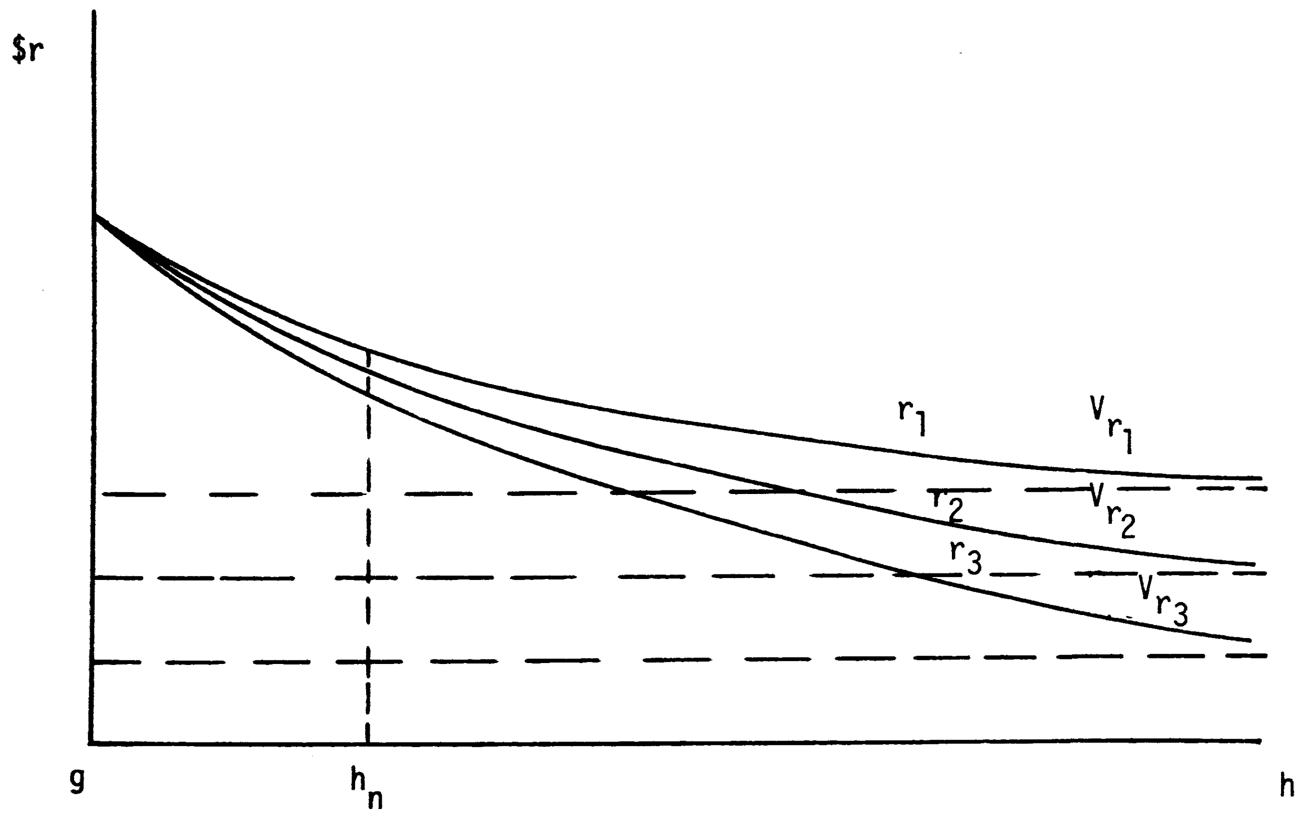
Figure 7.4



(with each property, of course, the size category may also change. This will cause the average rent function to move up and down, as well as change its shape, from property to property).

How will the average rent function behave if the vacancy rate varies vertically and horizontally? For instance, suppose the vacancy rate[1] on the upper floors increases relative to the rate on the lower floors (this may occur in a situation of oversupply of office space - since retail space is generally confined to the lower floors expansion of the supply of retail space is more restricted). This will place the upper floor tenants in a relatively better bargaining position than the lower floor tenants and a per unit decrease in upper floor rentals may be expected to follow. If this occurs the average rent function will appear to pivot downwards and will have a new lower asymptote (Figure 7.5). (β will increase indicating a more rapid fall-off in rentals at any height, λ will decrease due to the fall in upper floor rentals, α will decrease a compensating amount to ensure the same rent obtains on the

Figure 7.5



1. The relationship between rent and vacancy is discussed in Section 11.2 below. For the present it is accepted that an increase in the vacancy rate brings about a reduction in rent. (See also the discussion in Section 6.2 above).

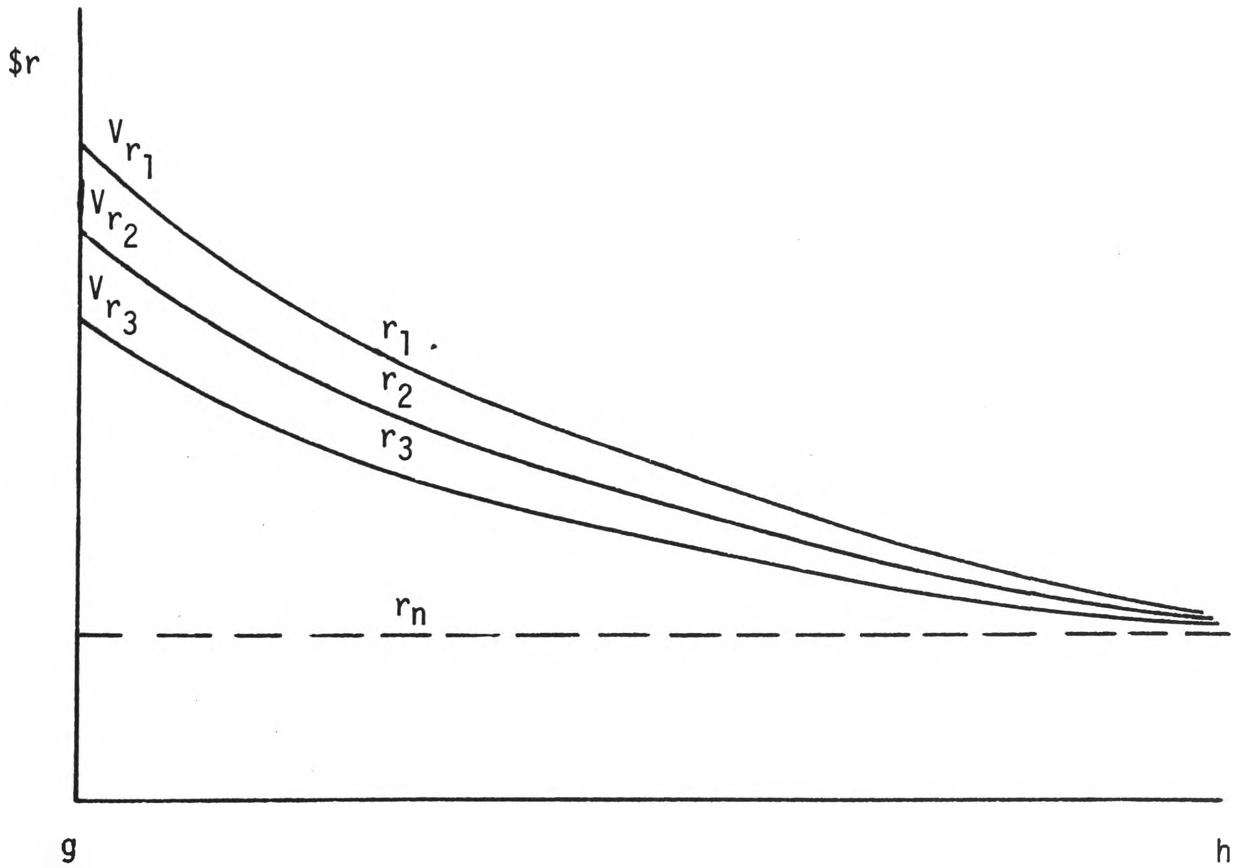
ground floor). In this situation there is a more rapid fall-off in rentals between ground and upper floors and this is depicted in the steeper average rent function. Here, at any height, h_n,

$$\frac{\partial r_1}{\partial h} < \frac{\partial r_2}{\partial h} < \frac{\partial r_3}{\partial h} \ . \ . \ . < \frac{\partial r_n}{\partial h} \qquad 7.4$$

where 1, 2 ... n denotes increasingly greater vacancy rates, Vr, on the upper floors.

On the other hand, suppose the vacancy rate on the lower floors increases relative to the upper floors. The constant upper floor rental, λ, will remain unchanged. However as the ground (and other lower) floor vacancy rate increases the per unit rent on these floors will decrease. That is, there is a relative decline in the desire for ground floor location. In this situation the absolute value of α will increase while β will decrease. The process suggests a lowering and flattening of the curve as in the following diagram:

Figure 7.6



Here:

$$\frac{\partial r_1}{\partial h} > \frac{\partial r_2}{\partial h} \; . \; . \; . > \frac{\partial r_n}{\partial h} \qquad 7.5$$

The neutral case occurs when there is no difference in per unit rents throughout a building as height increases. In this situation $r = \lambda$ throughout the building.

Or, suppose that one part of the peripheral central city has a greater vacancy rate than another, putting the landlords in the former area in a relatively worse bargaining position (assume that some factors operate in order to make the tenants relatively immobile - at least in the short run. If this wasn't the case there would be a general fall in occupancy in the peripheral parts of the CBD since tenants would move from low vacancy to high vacancy areas. Such immobilising factors may be the special accessibility defined by Turvey.[1]) This will result in a more rapid fall-off in per unit rentals on all floors towards the high vacancy area than in other directions. In this case the entire average rent function is lower on each property in this area than in other areas.

Consider the situation which may arise in some cities where the rent obtainable on the upper floors may be greater than the rent on the lower floors. Suppose per unit rents increase on each floor up to, say, the twentieth floor above which the rent is constant. Naturally this produces quite a reverse situation to the previous case. Here the average rent function intersects the vertical (rent) axis at the ground floor rent level but, unlike the previous case, it increases at a decreasing rate towards an asymptotic level determined by the constant rent factor. Once again this behaviour may be represented by a rectangular hyperbola such as:

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1. Turvey, op.cit., pp. 48-49.

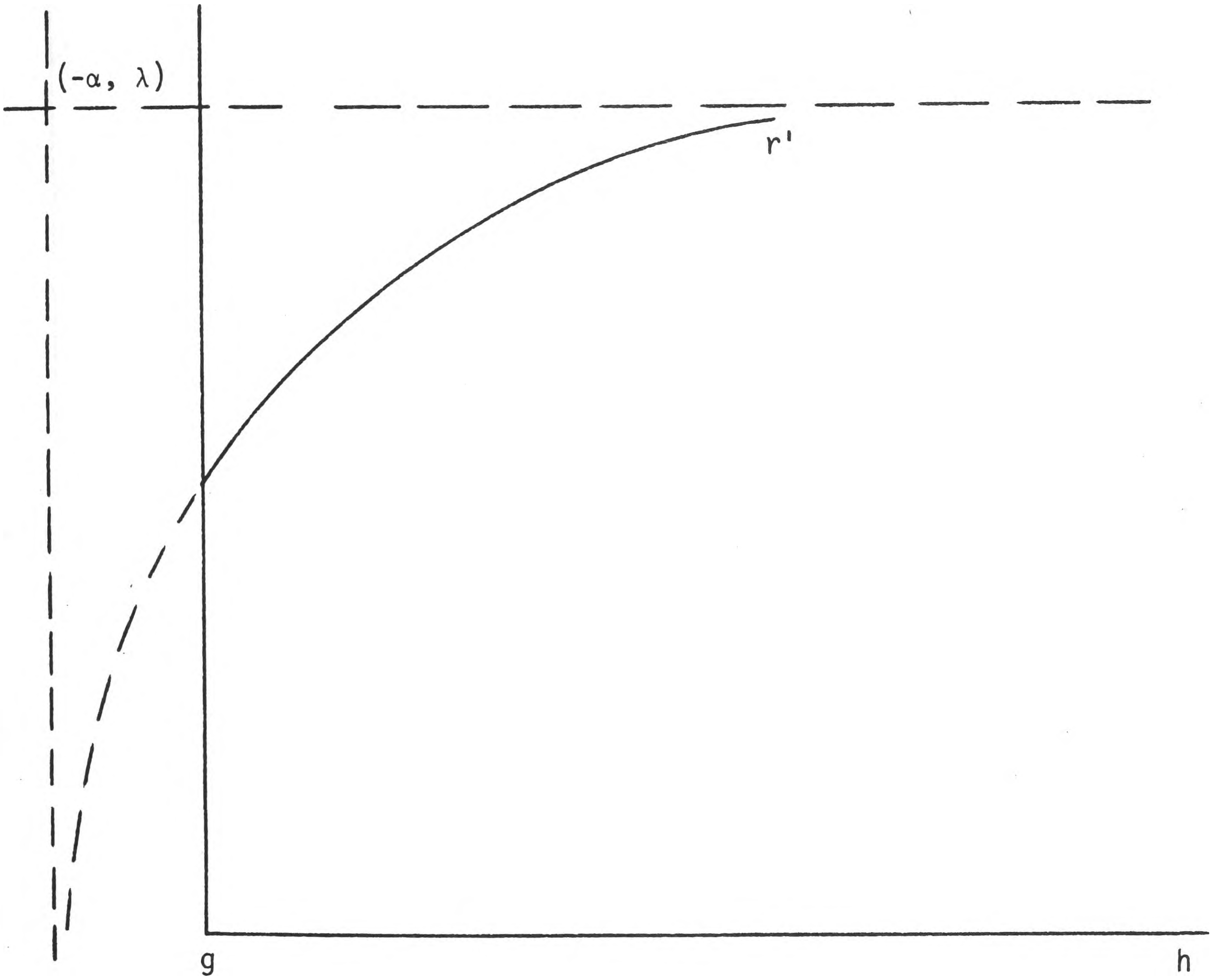
$$r' = \frac{\beta'}{h + \alpha'} + \lambda' \qquad 7.6$$

But a restrictive condition is necessary such that

$$\frac{\partial r'}{\partial h} > 0$$

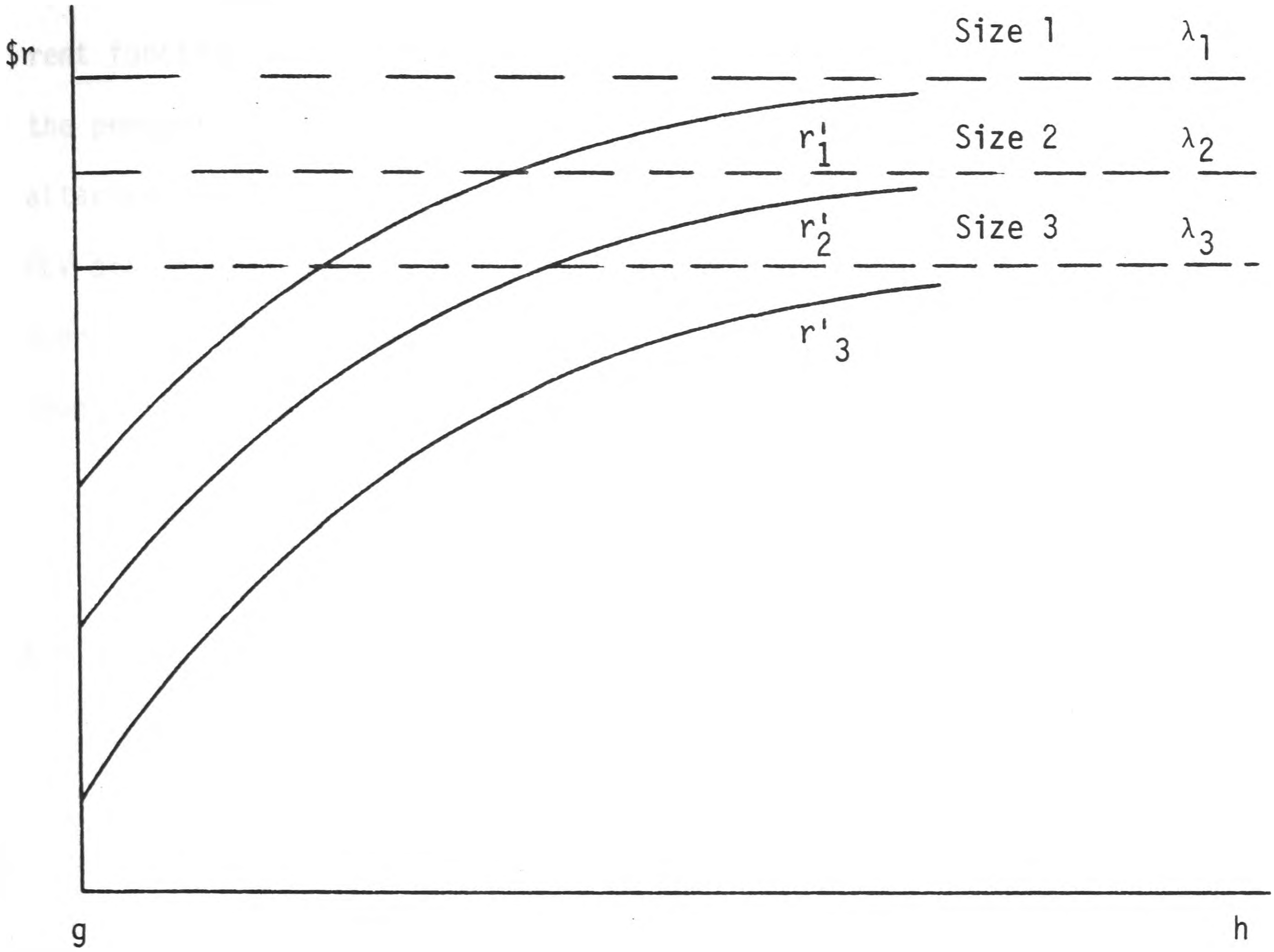
Such an average rent function is shown in the following diagram:

Figure 7.7



There are some differences and some similarities, to the previous case, in the behaviour of this function. Behaviour which is dependent on bargaining power will be similar. If an LMD situation prevails the function will be shifted downwards as the size category increases, as shown in Figure 7.8.

Figure 7.8



Here:

$$\frac{\partial r_1}{\partial h} = \frac{\partial r_2}{\partial h} = \; . \; . \; . = \frac{\partial r_n}{\partial h} \qquad 7.7$$

but $\lambda_1 < \lambda_2 < \; . \; . \; . < \lambda_n$

The opposite condition prevails if a UMD situation exists, that is the rent function will be shifted upwards as the size category increases, but the slope of the function will remain unchanged.

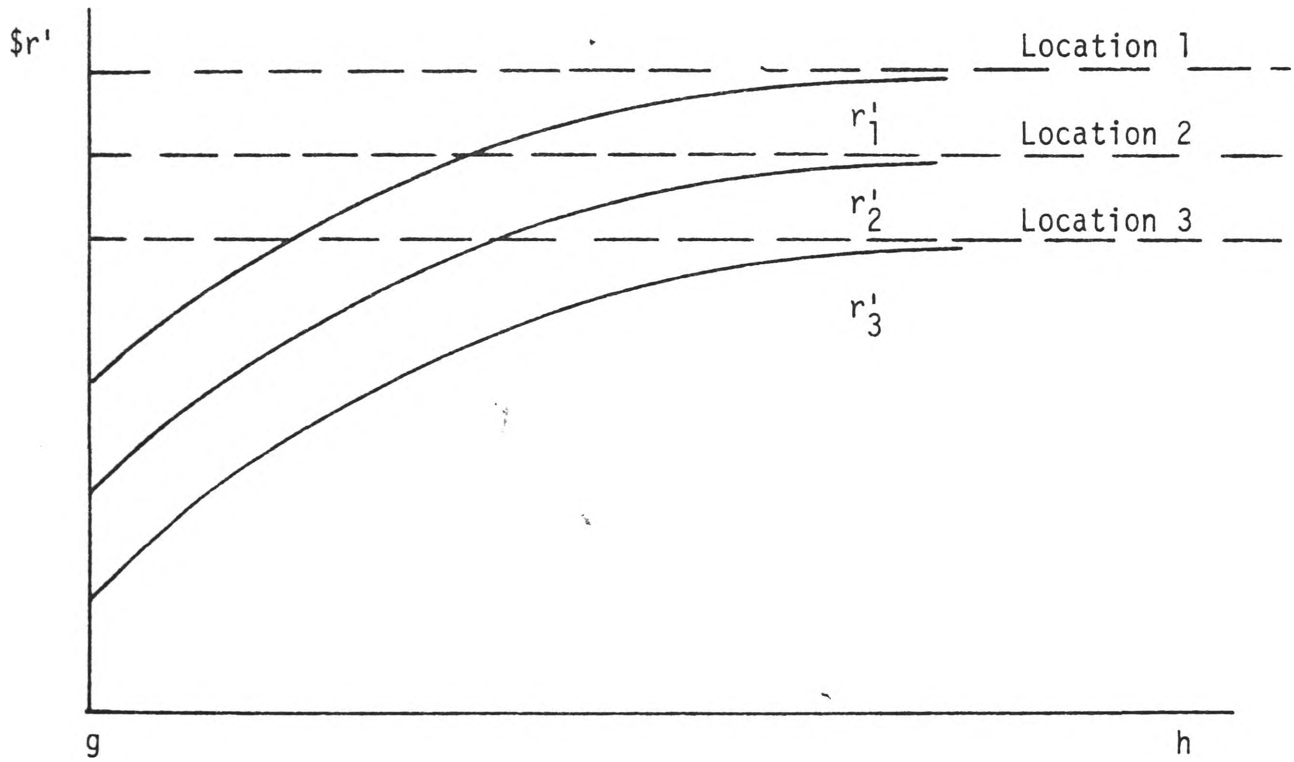
If there is a general increase in the vacancy rate the entire function will be shifted downwards for all size categories (and vice versa for a decrease in the vacancy rate) but the slope of the curve will remain unchanged. This behaviour is the same as with the previous case.

The primary difference in behaviour between this and the previous rent function relates to the behaviour with respect to location. With the present rent function there is no special accessibility factor attached to a ground floor location. Therefore as distance from the PLV site increases only the force of general accessibility is in operation. Thus the entire curve is shifted downwards but does not change its shape. This is shown in Figure 7.9. Here:

$$\frac{\partial r_1}{\partial h} = \frac{\partial r_2}{\partial h} = \ . \ . \ . = \frac{\partial r_n}{\partial h} \qquad 7.8$$

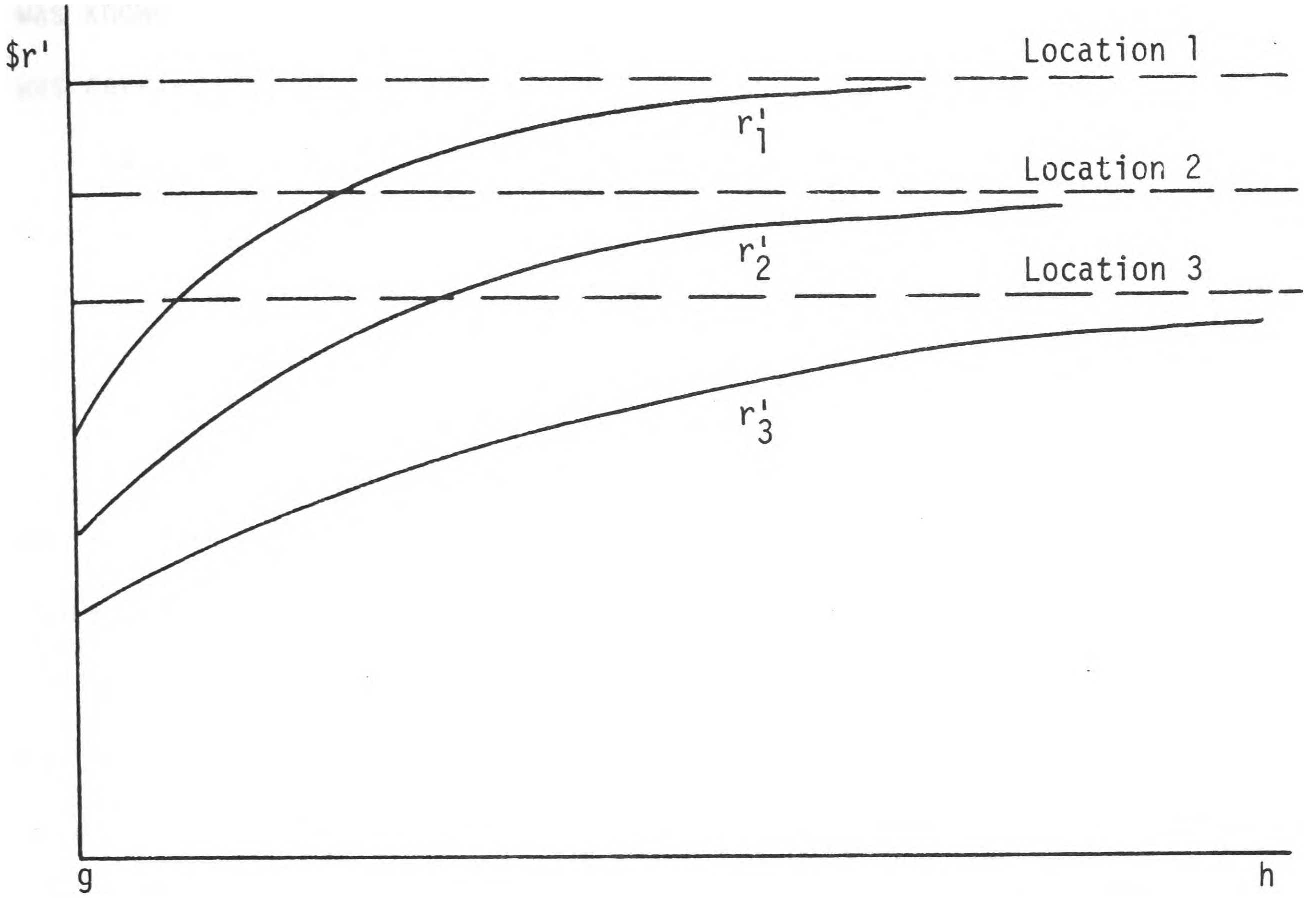
and $\lambda_1 < \lambda_2 < . \ . \ . < \lambda_n$

Figure 7.9



It may be, however, that as distance from the PLV site increases (beyone a point) the relatively greater attraction for an upper floor rather than a lower floor location decreases. Therefore, as distance increases, the curve will be lowered and will appear to pivot upwards on its axis so that the slope will decrease at any height. This is shown in the following diagram.

Figure 7.10



Here:

$$\frac{\partial r_1}{\partial h} > \frac{\partial r_2}{\partial h} > \ . \ \ . \ \ . \ > \frac{\partial r_n}{\partial h} \qquad 7.9$$

7.3 <u>Tests of the Hypotheses</u>

Since Wollongong has few tall buildings tests of the average rent function hypothesis were quite limited in scope. Up until 1972/73 (the latest period for which rental data were available) there were only five buildings in Wollongong's CBD which had five or more storeys (excluding basement and lower floors) and these are shown in Table 7.2. Average rent data for varying heights on each building site were calculated on the assumption that the market rent actually obtained for each floor would have been obtained irrespective of the number of floors above. There is no reason to suppose that this was a particularly strong assumption in Wollongong's case.

In each building r and h formed the series of observations and λ was known. Independent estimates had to be formed for each α. This was carried out by

(a) restating the average rent function as

$$h = \frac{\beta}{r - \lambda} - \alpha \qquad 7.10$$

(b) defining a new variable

$$z = \left(\frac{1}{r - \lambda}\right) \qquad 7.11$$

and 'running' a series of regressions to obtain $\hat{\alpha}$. The results of these regressions for the four valuation years between 1958 and 1972 (inclusive) are shown in Table 7.3. In the regression analyses a value of one was applied to the ground floor observations. Therefore, although the $\hat{\alpha}$ values in Table 7.3 are both positive and negative, all of the estimates lie to the left of the rent/height origin (1, 0) as hypothesised.

The alpha estimates were then introduced into equation 7.1 and a series of regressions were carried out to obtain estimates of β and λ. These results are shown in Table 7.4. In each case the variation 'explained' by the regression was high and the F-ratio was significant at the .01 level. The β and λ estimates are also shown in Table 7.4 and these were similarly found to be significant at the .01 level. Because of the estimating technique used one would not expect the $\hat{\lambda}$ to differ greatly from the λ. In Table 7.4 it can be seen that in only 3 instances did the estimated lambda differ from lambda by more than 10 percent.

Table 7.5 lists the slope of the average rent function at the first floor. The main purpose of the table is to indicate the changes in slope brought about by the special accessibility factor related to height (ground floor accessibility). Properties 1, 2 and 3 are located

TABLE 7.3

ALPHA ESTIMATES

YEAR	Code	$\hat{\alpha}$	Se(Coef)
1972	1	-0.065	0.057
	2	0.544	0.132
	3	0.243	0.089
	4	-0.045	0.038
	5	-0.374	0.070
1967	1	-0.065*	-0.067
	2	-0.404	0.104
	3	0.267	-0.096
	4	-0.056*	0.048
	5	0.534	0.117
1962	1	-0.065*	-0.067
	2	-0.198	-0.041
	4	-0.056*	0.048
	5	0.541	0.144
1958	2	-0.341	-0.085
	4	-0.046*	0.027
	5	0.473	0.049

* Not significant at the .05 level. But this is ultimately of no consequence since a value of 1 was applied to the ground floor observations. That is, the rent/height origin is at the point (1,0), so that the vertical asymptote at the point (0,0) will lie to the left of origin.

TABLE 7.4

BETA AND LAMBDA ESTIMATES

YEAR	Code	$\hat{\beta}$[1]	Se (coef)	$\hat{\lambda}$[1]	Se	λ	$(\lambda-\hat{\lambda})$	$\frac{\lambda-\hat{\lambda}}{\lambda}$
1972	1	2.49	0.091	1.38	0.048	1.25	-0.13	0.10
	2	1.01	0.023	2.35	0.009	2.36	0.01	0.004
	3	6.76	0.162	2.76	0.064	3.00	0.24	0.08
	4	2.33	0.025	2.56	0.014	2.50	-0.06	0.02
	5	1.58	0.010	2.17	0.008	2.20	0.03	0.01
1967	1	1.99	0.077	1.11	0.040	1.00	-0.11	0.11
	2	2.84	0.036	2.47	0.030	2.34	-0.13	0.06
	3	5.97	0.138	2.36	0.053	2.58	0.22	0.09
	4	1.01	0.012	2.43	0.007	2.40	-0.03	0.01
	5	4.51	0.441	1.45	0.170	2.10	0.65	0.31
1962	1	1.99	0.077	1.11	0.040	1.00	-0.11	0.11
	2	4.28	0.012	2.32	0.008	2.27	-0.05	0.02
	4	1.01	0.012	2.43	0.007	2.40	-0.03	0.01
	5	1.89	0.187	1.98	0.072	2.27	0.27	0.14
1958	2	2.66	0.033	2.03	0.025	1.93	-0.10	0.05
	4	1.17	0.013	2.77	0.007	2.74	-0.03	0.01
	5	1.00	0.097	1.53	0.038	1.67	0.14	0.08

1. All significant at the .05 level.

on Crown Street and properties 4 and 5 in Keira Street. Property 3 is located at the main intersection of Crown and Keira Streets. Properties 1 and 5 are also located on corners. All of the properties except number 4 have retail activities on the ground floor. In this very limited number of cases available for testing (17 over the period) the influence of special accessibility on the slope of the function is generally clear. Properties located in Crown Street usually have a more rapid decline in average rent as height increases. Of the 17 observations over the period this was not the case in 2 instances. Due to the limited number of properties it is difficult to distinguish between the influence of Crown Street and the influence of the corner location. Of the 17 observations 9 were at corner locations.

Another difficulty is that the floor space categories were not homogeneous horizontally or vertically. This is indicated by Table 7.6 which lists the mean floor space per floor and the number of tenants per floor in 1972. The evidence presented in Table 7.6 does not support the assumption that the landlord/developer does not attempt to spread his risks by supplying floor space in different categories throughout a building. In only one instance was the floor space category a constant throughout the building. It is interesting, however, to compare the occupants per building with the height of the average rent function for 1972 (as shown in Figure 7.11 for simulated values). There is a general agreement with the hypothesis that the smaller the size category the higher the average rent function. The most notable exception is provided by the CML building - which is the best located and the newest building (completed in 1965 compared with about 1957 for the other buildings).

TABLE 7.5

SLOPE AT FIRST FLOOR

Code	1972	1967	1962	1958
1	-0.67	-0.53	-0.53	-
2	-0.16	-1.11	-1.32	-0.97
3	-1.34	-1.16	-	-
4	-0.61	-0.27	-0.27	-0.28
5	-0.97	-0.70	-0.29	-0.09

Figure 7.11

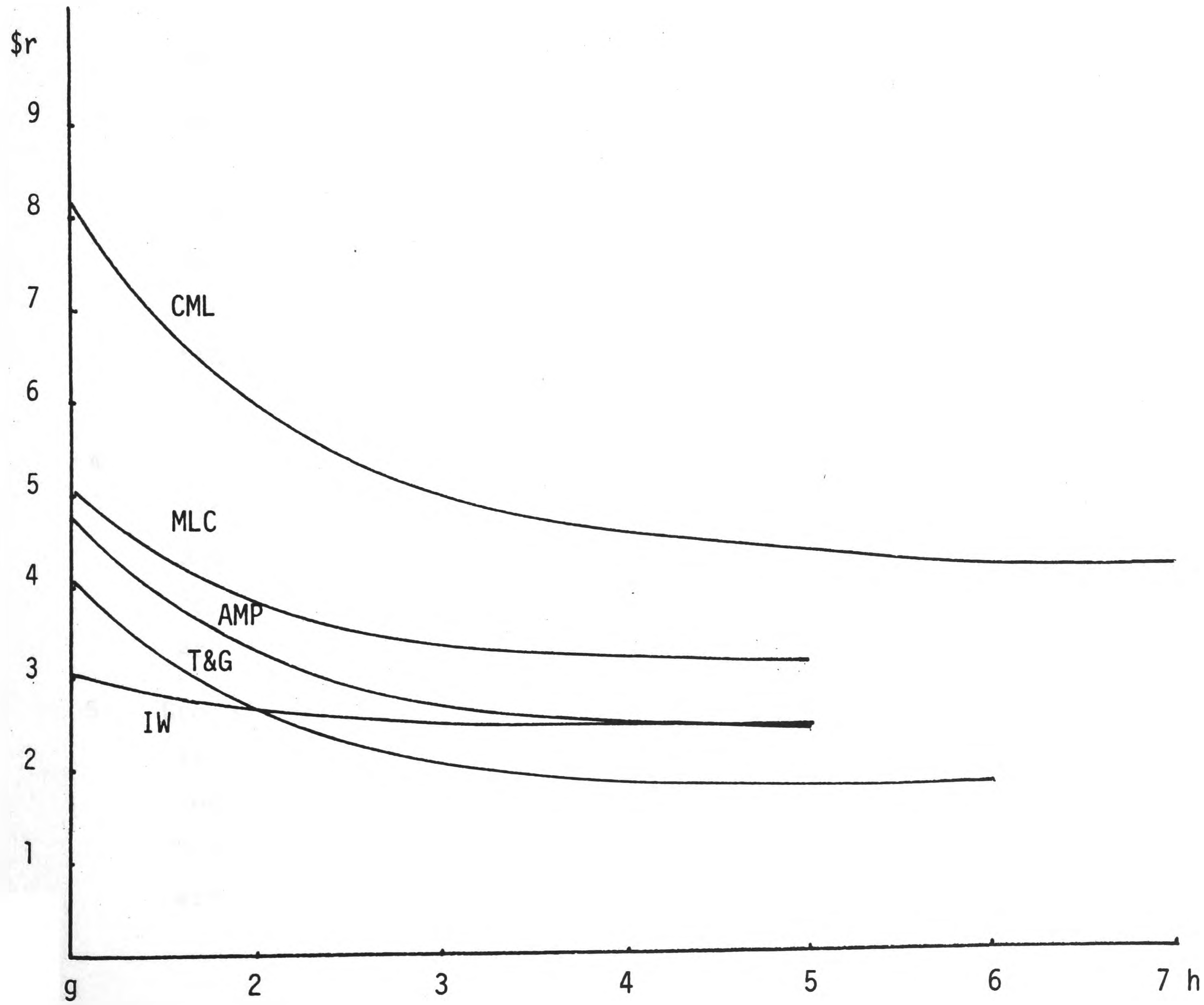


TABLE 7.6

NUMBER OF OCCUPANTS PER PROJECT, 1972

Code	Floor	Mean Floor Size	No. of Occupants[a]	Mean Size Per Occupant Per Floor	Mean Size Per Occupant Per Building
1	Ground	3933	4	983	
	1st		1	3933	
	2nd		2	1966	1124
	3rd		3	1311	
	4th		8	500	
	5th		3	1311	
2	Ground	4575	1	4575	
	1st		1	4575	4575
	2nd		1	4575	
	3rd		1	4575	
	4th		1	4575	
3	Ground	3522	2	1761	
	1st		1	3522	
	2nd		6	600	
	3rd		5	704	919
	4th		4	880	
	5th		4	880	
	6th		1	3522	
4	Ground	1414	1	1414	
	1st		3	471	505
	2nd		4	353	
	3rd		4	353	
	4th		2	707	
5	Ground	5996	5	1199	
	1st		8	750	
	2nd		18	333	461
	3rd		28	214	
	4th		6	1000	

a. Field Survey.

7.4 A Total Revenue Function and its Use

Given this analysis how may the revenue obtainable from differing potential development intensities be expected to vary? Since the quantity of floor space on each floor is assumed to be a constant the total quantity of floor space on a given site may be written as:

$$q = \theta h \qquad 7.12$$

Therefore the average rent function may be expressed as:

$$r = \frac{\beta\theta}{q + \theta\alpha} + \lambda \qquad 7.13$$

Total revenue may then be expressed as a hyperbolic function of the level of development:

$$R = \frac{\beta\theta q}{q + \theta\alpha} + \lambda q \qquad 7.14$$

There are some notable features of total revenue in this instance. For example total revenue will increase continuously as the height of the building increases, but it will do so at a decreasing rate. In other words (i) marginal revenue will decrease as development intensity increases and (ii) there will be no maximum total revenue. This can be easily seen by looking at marginal revenue and its rate of change. Marginal revenue is given by:

$$\frac{\partial R}{\partial q} = \frac{\beta\theta^2\alpha}{(q + \theta\alpha)^2} + \lambda \qquad 7.15$$

For all positive values of q marginal revenue is positive. However, marginal revenue is decreasing since the rate of change of marginal revenue is negative in the positive quadrant. There is no maximum since,

$$\frac{\partial^2 R}{\partial q^2} = - \frac{2\beta\theta^2\alpha}{(q + \theta\alpha)^3} \qquad 7.16$$

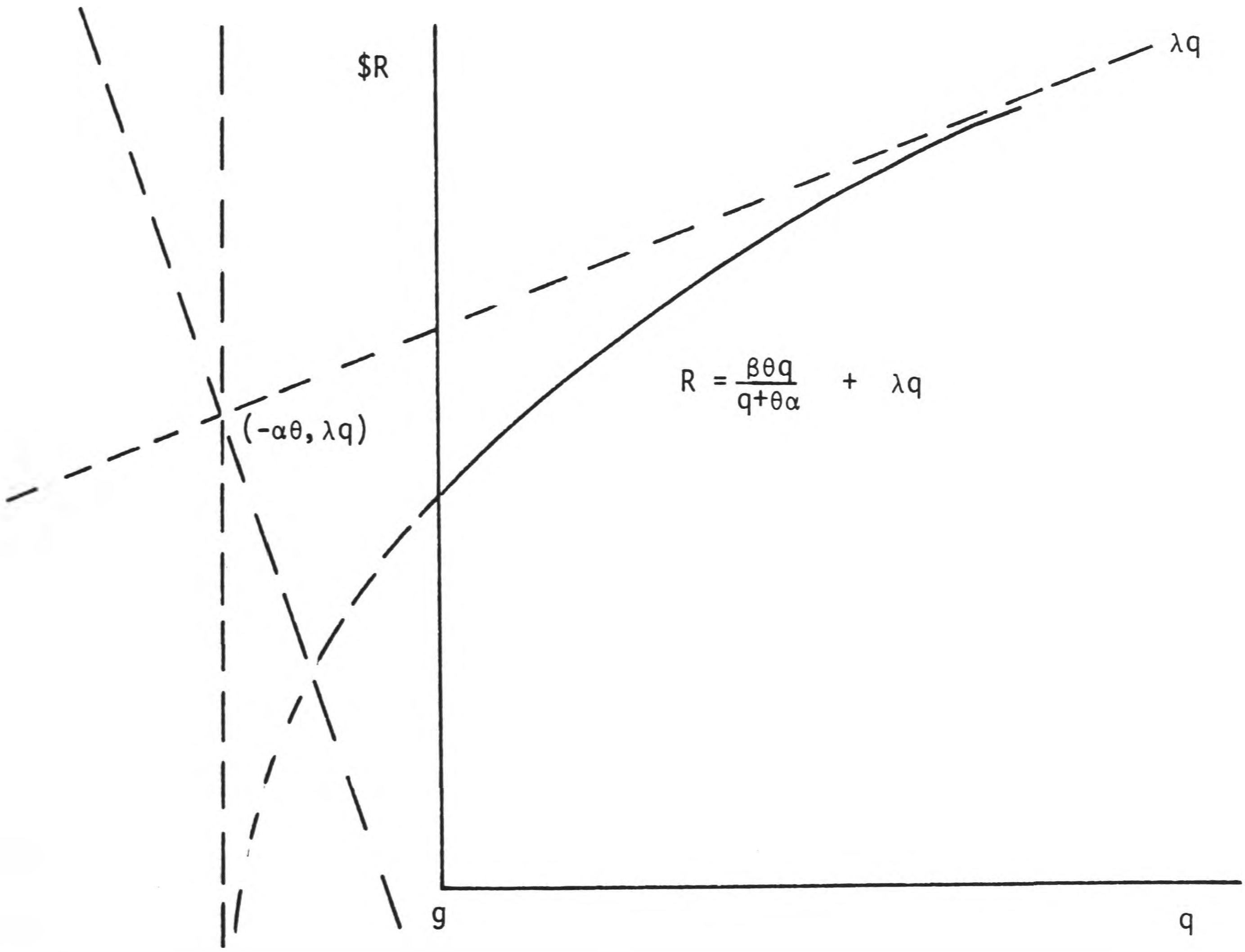
when marginal revenue is zero

$$q = \sqrt{-\frac{\beta\theta^2\alpha}{\lambda}} - \theta\alpha \qquad 7.17$$

which is imaginary. Total revenue is shown diagrammatically in Figure 7.12. Here the revenue function is described by a hyperbola whose centre is given by

$$q = -\theta\alpha \text{ and } R = \lambda q \qquad 7.18$$

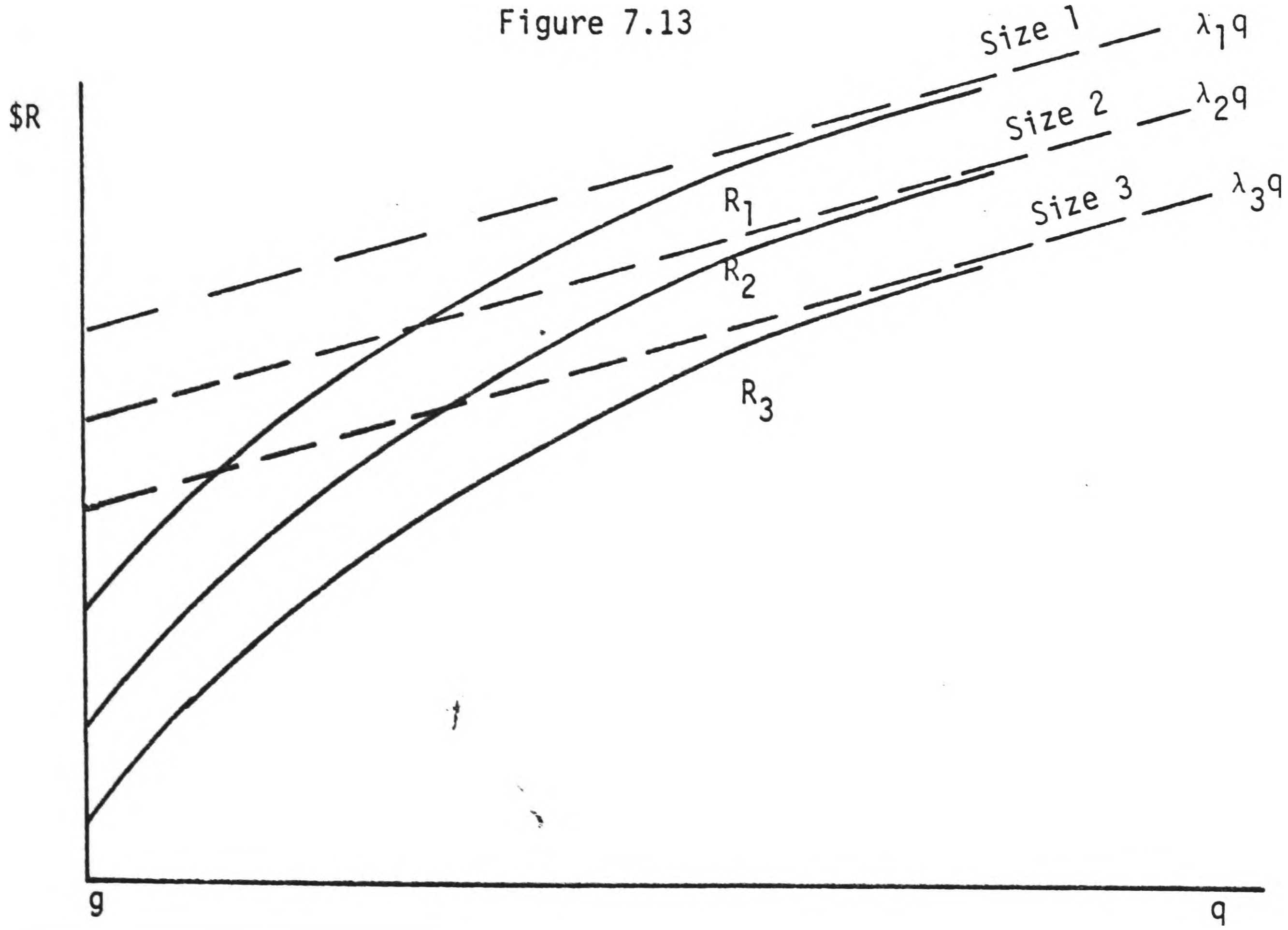
Figure 7.12



(when q = θ at ground floor level or the upper asymptote). The asymptote $R = \lambda q$ is a straight line with slope λ. That is, its slope, and hence the height of the total revenue curve is determined by the constant rental obtainable on the upper floors. As the building becomes taller revenue approaches a constant increase. The intercept which the revenue curve makes with the vertical axis is determined by the ground floor rental and the constant quantity of floor space θ.

Suppose that a lower modal distribution prevails and a higher per unit rental is obtainable in the smaller size categories. How will the total revenue function behave as the size category increases (maintaining the assumptions associated with Figure 7.3)? Refer to Figure 7.13.

Figure 7.13



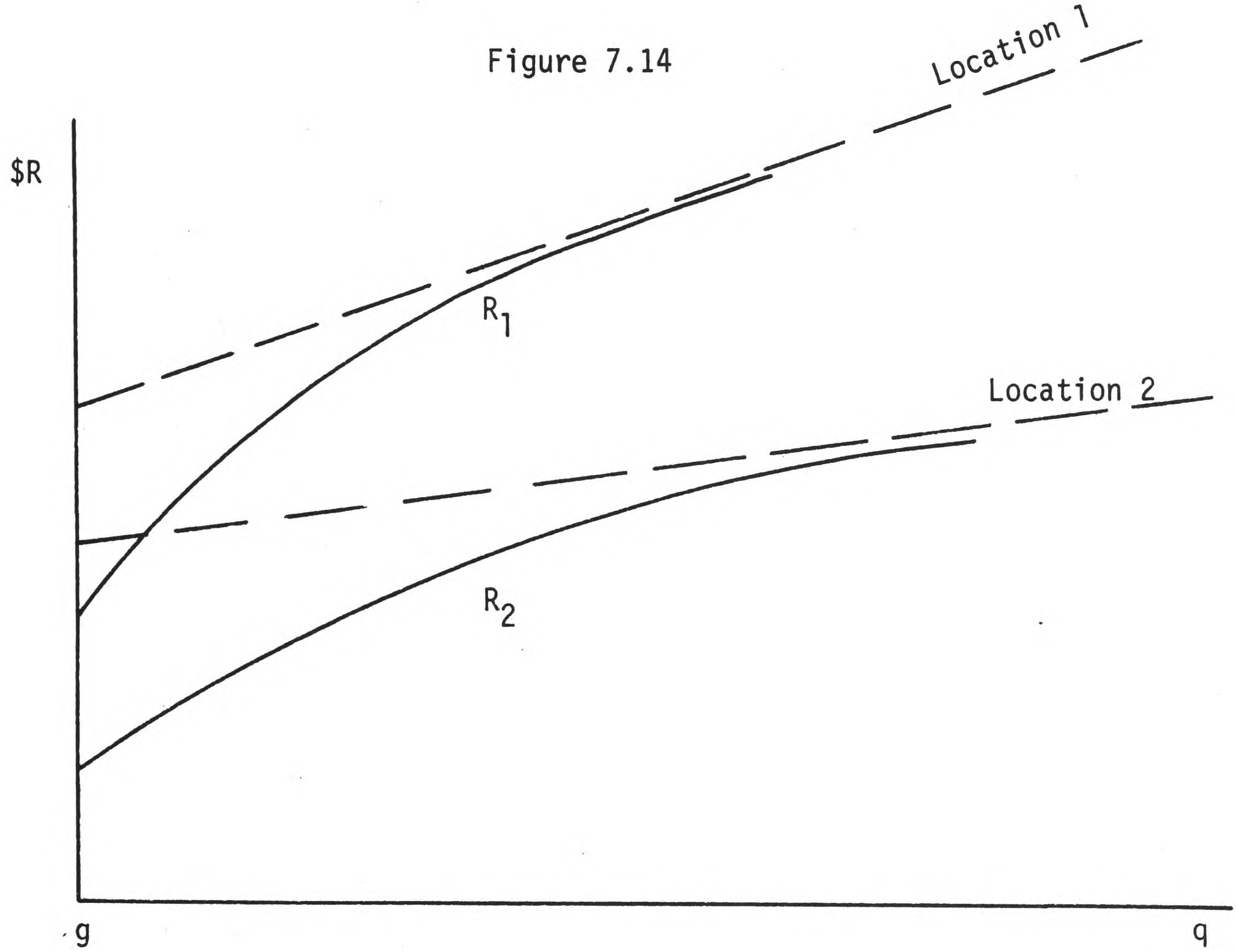
Here there are two distinct simultaneous movements in the revenue function. The curve is moved (i) downwards and (ii) to the left (since α decreases and a lower average rent is obtainable in the new size categories). The slope of the curve will be the same at any given height i.e.

$$\frac{\partial R_1}{\partial q} = \frac{\partial R_2}{\partial q} = \ . \ . \ . \ \frac{\partial R_n}{\partial q} \qquad 7.19$$

That is, in an LMD situation as the size category increases (i) the total revenue obtainable from any given level of development decreases but (ii) the marginal revanue at any given height will remain unchanged.

Within a given size category as distance from the PLV site increases the revenue function (i) will be lowered and shifted to the left since α decreases and a lower average rent is obtainable (ii) will pivot downwards since there will be a less rapid fall-off in revenue at greater heights (λ and β will decrease). This is shown in Figure 7.14.

Figure 7.14



In the above diagram

$$\frac{\partial R_1}{\partial q} > \frac{\partial R_2}{\partial q} > \ . \ . \ . \ \frac{\partial R_n}{\partial q} \qquad 7.20$$

where 1, 2 . . . n represents locations increasingly distant from the PLV site.

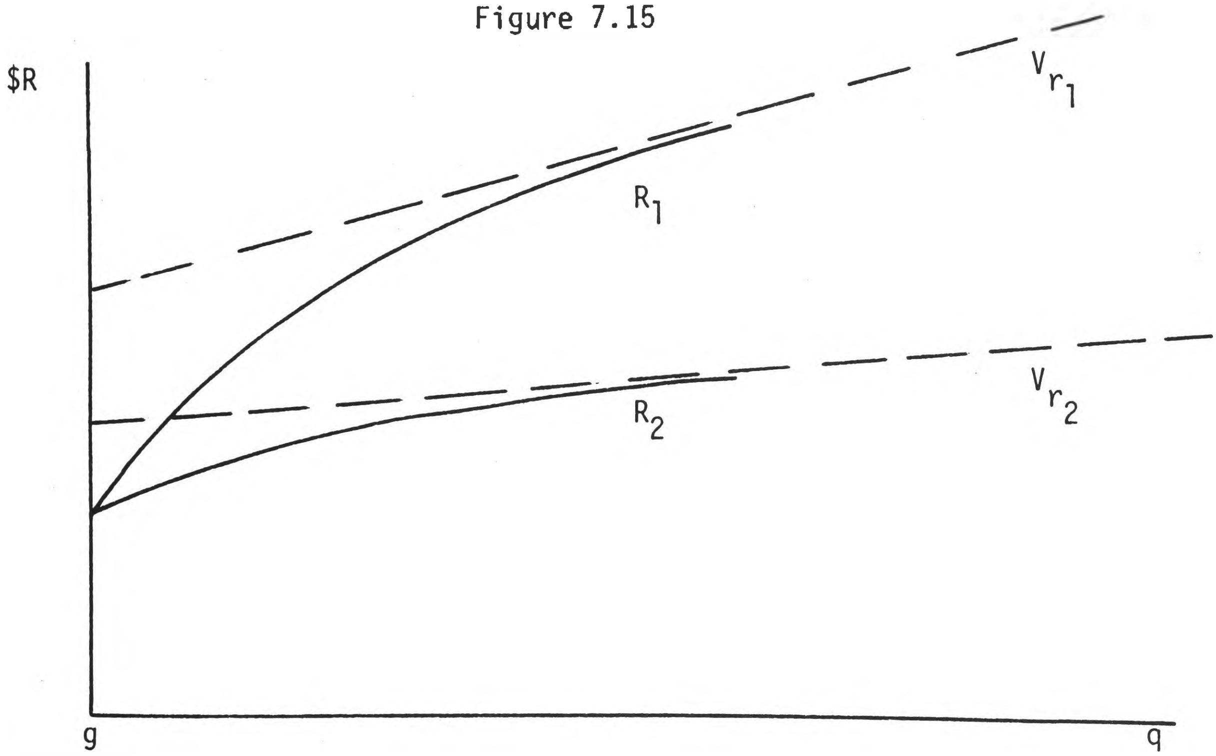
Thus there is a reduced revenue incentive to build high as one moves towards the periphery (a reflection of the fall-off in demand due to a decline in general accessibility) and as the size category increases in the case of LMD situations.

Provided minimum[1] rents have not been attained a general increase in the vacancy rate will bring about a reduction in per unit rentals. The behaviour of the revenue function will be similar to that shown in Figure 7.14 above. An increase in the vacancy rate on the upper floors relative to the ground floor will pivot the revenue curve downwards (λ will decline) and there will be a sharper decline in the rate of increas in total revenue between ground and upper floors (β will increase). This is shown in Figure 7.15. Here

$$\frac{\partial R_1}{\partial q} > \frac{\partial R_2}{\partial q} > \ldots \frac{\partial R_n}{\partial q} \qquad 7.21$$

but $R_1 = R_2 = \ldots R_n$ at g.

Figure 7.15



1. Blank and Winnick, op.cit., pp. 188-192, point to the fact that there will be some minimum rent which will form the limit of the landlord's rent reductions irrespective of the vacancy rate. A decrease in rent beyond this 'floor' limit will result in the space being withdrawn from the market.

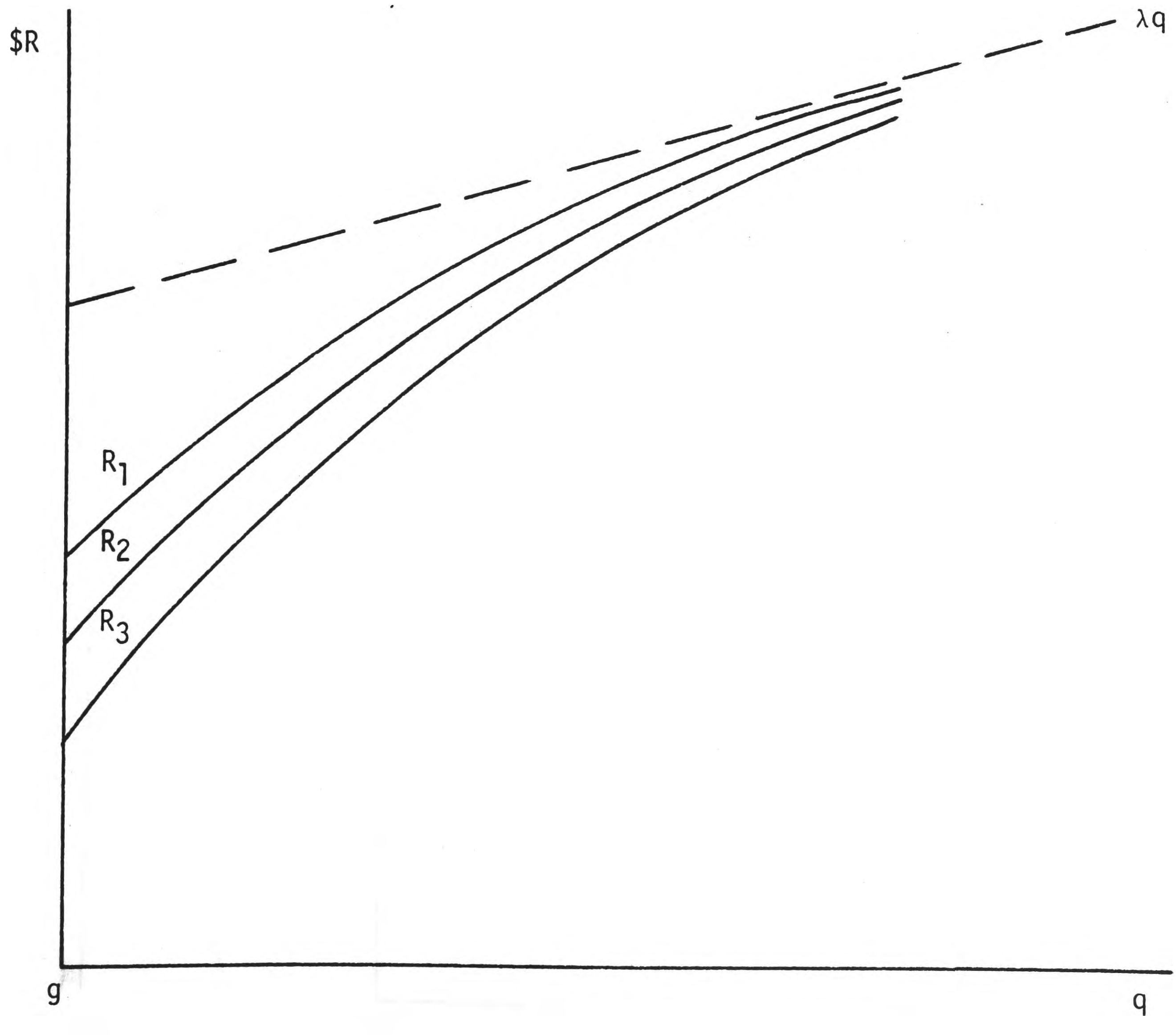
On the other hand an increase in the vacancy rate on the ground and lower floors relative to the upper floors will pivot the revenue curve downwards but will leave λ unchanged. In this case there will be an increase in the rate of increase of total revenue as height increases, that is, the slope of the function will become steeper so that:

$$\frac{\partial R_1}{\partial q} < \frac{\partial R_2}{\partial q} < \ . \ . \ . \ < \frac{\partial R_n}{\partial q} \qquad 7.22$$

and $R_1 < R_2 < \ . \ . \ . \ < R_n$ at g.

This behaviour is shown in the following diagram:

Figure 7.16



Now, consider the case in which per unit rentals increase as height above ground floor increases (and are constant after some given height). The effect may be best described as a swivelling of R on the asymptote λq as an axis of revolution. This, of course, produces a completely reverse total revenue function to the one previously described, although once again total revenue may be expressed as a hyperbolic function of the level of development such as:

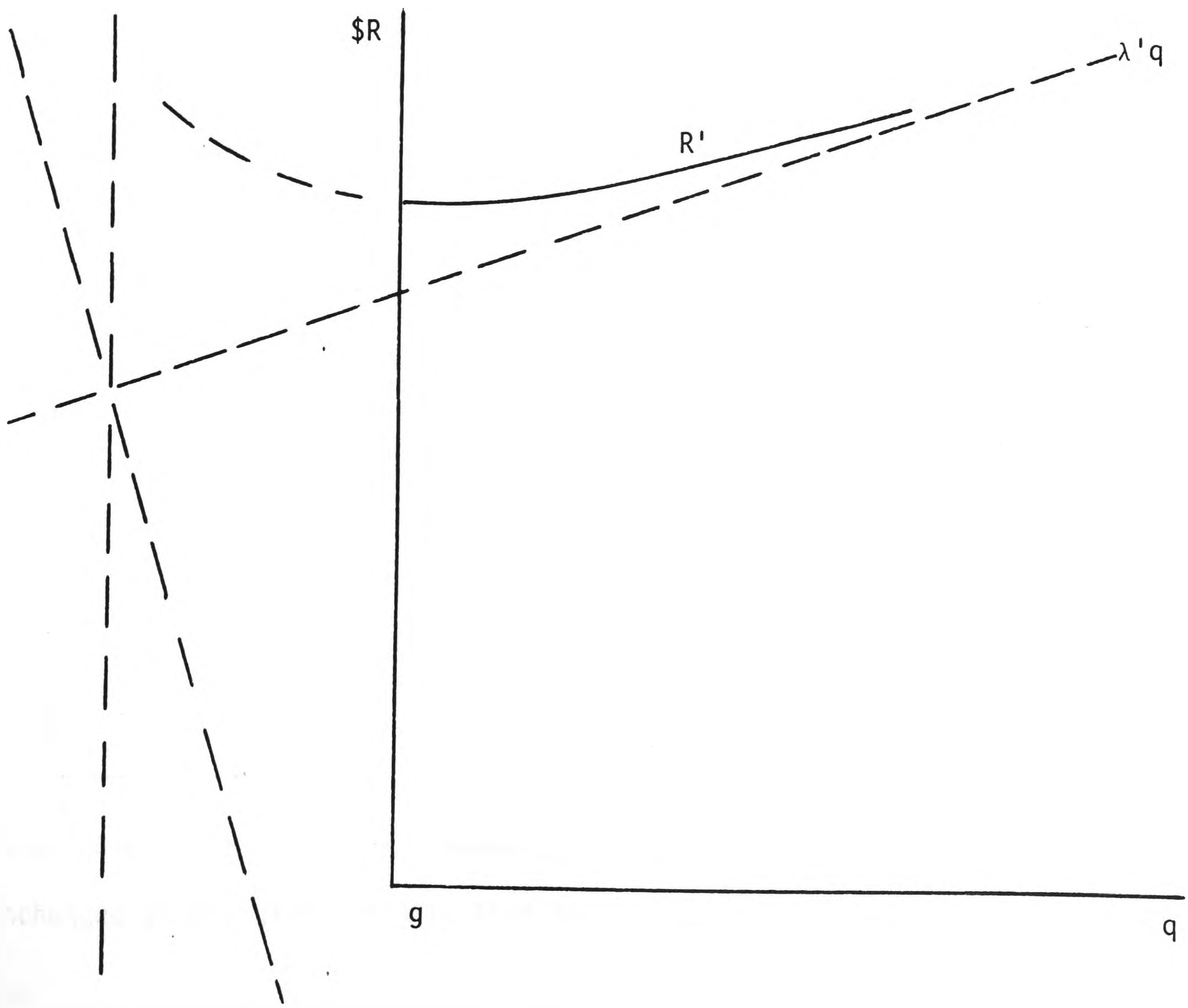
$$R' = \frac{\beta'\theta q}{q + \theta\alpha'} + \lambda' q \qquad 7.23$$

but maintaining the condition

$$\frac{\partial r'}{\partial h} > 0$$

This function may be expressed diagrammatically in the following way:

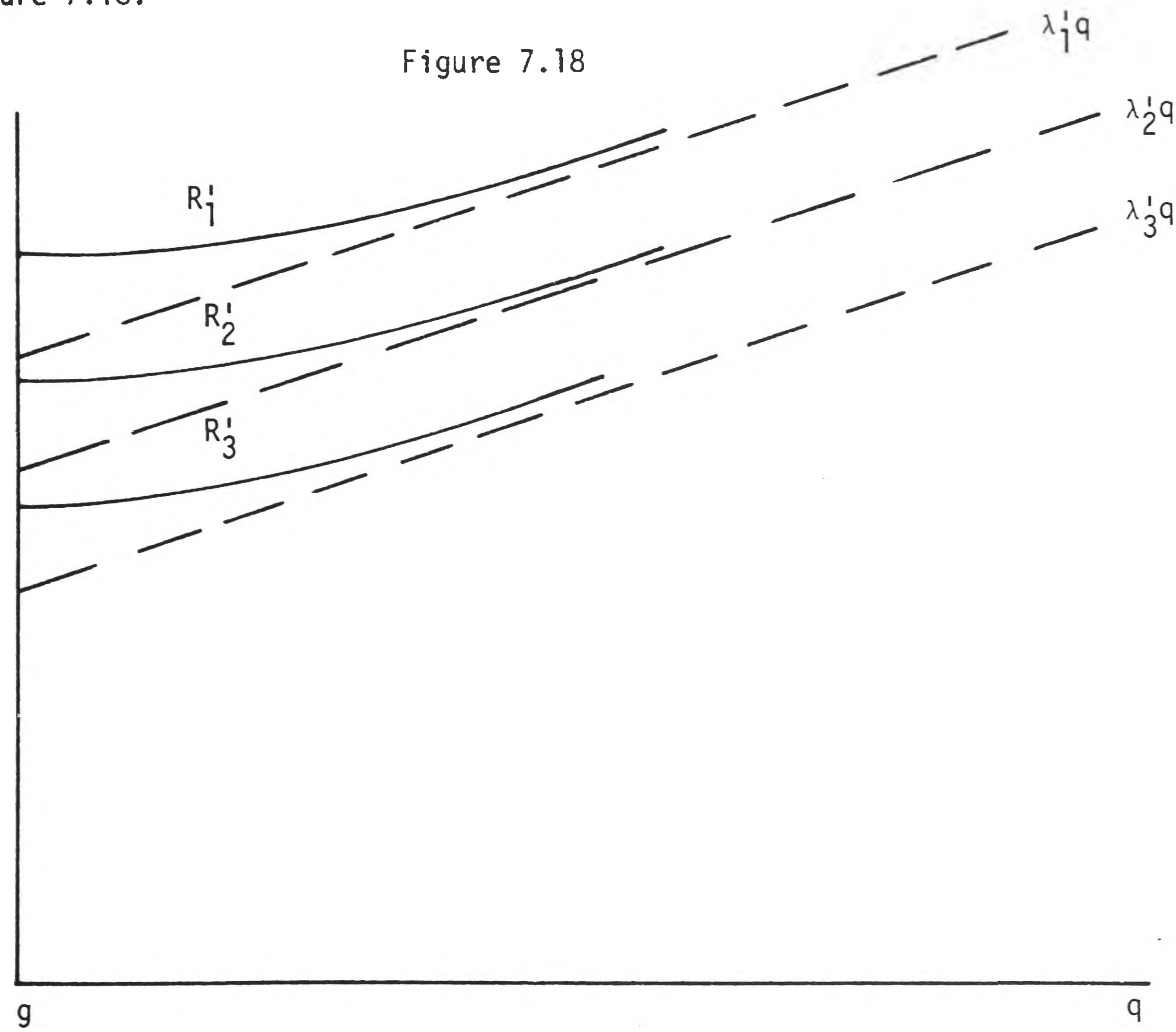
Figure 7.17



Initially the function will increase at an increasing rate but the tendency will be ultimately towards a constant increase. That is, marginal revenue will initially increase as development intensity increases, but will eventually attain a horizontal (unchanging) level as development intensity increases. Again there is no maximum total revenue.

In most cases the behaviour of the revenue function will be similar to that described for the situation where per unit rent decreases as height increases above ground floor level. For instance, in the case where behaviour is dependent upon bargaining power then an LMD situation will result in a downwards movement in the revenue function as the size category increases (and vice versa for a UMD situation) as shown in Figure 7.18.

Figure 7.18



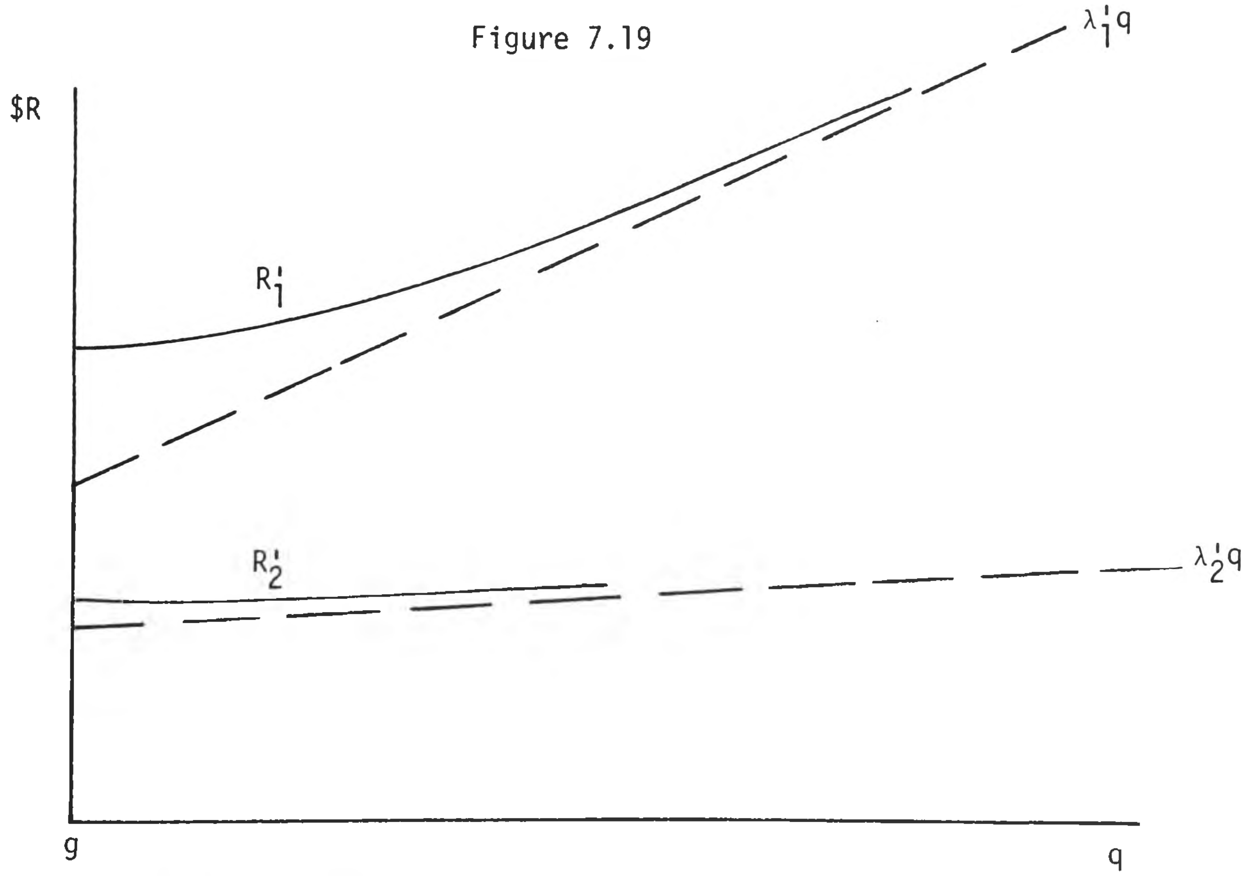
Here, although total revenue decreases marginal revenue will remain unchanged at any given height, that is:

$$\frac{\partial R_1'}{\partial q} = \frac{\partial R_2'}{\partial q} = \ldots \frac{\partial R_n'}{\partial q} \qquad 7.24$$

If there is a general increase in the vacancy rate the revenue function will similarly be shifted downwards without a change in slope. The behaviour is diagrammatically similar to that in the above figure.

If there is no change in relative desire between lower and upper floor location as distance from the PLV site increases the revenue function will again be shifted downwards without change in slope. Again the effect is similar to that shown in the above diagram. However if there is a decrease in the relative desire for upper floor location as distance from the PLV site increases then the revenue curve will be lowered but will appear to pivot upwards from the origin as shown in the following diagram:

Figure 7.19



Here:

$$\frac{\partial R_1'}{\partial q} > \frac{\partial R_2'}{\partial q} > \ldots \frac{\partial R_n'}{\partial q} \qquad 7.25$$

That is, the rate of increase in revenue as height increases will not be as great.

7.5 The Capitalisation Rate and Total Property Value

Total property value may be defined as the maximum price an individual (or firm) is prepared to pay for a particular property. This maximum will be different for different individuals. Suppose that all individuals who seek an ownership interest in property are investors (rather than owner-occupiers). For such individuals property value may be defined as the present worth of future income streams. That is, total property value will equal the present value to the individual of the anticipated net income discounted at a rate of interest equal to the yield obtainable on alternative investments with similar characteristics.[1] This rate of interest is known as the capitalisation (discount) rate and, ceteris paribus, the issue of property value may be said to centre around this rate. Minor alterations in the capitalisation rate will produce very substantial changes in present value. The capitalisation rate itself reflects the riskiness of the investment, the expected duration of the income and the price at which alternative investment interests can be acquired.

If the individual could either borrow all of the funds necessary to buy (build) the property, or, if he had sufficient funds to purchase the property entirely from his own resources, determination of the capitalisation rate would be a relatively simple matter. In the first instance the relevant rate of interest is the rate at which the individual would have to borrow in order to buy the property, plus an allowance proportionate to the degree of uncertainty. In the second case it is the

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1. Murray argues that "The capitalisation rate, in the case of real estate, is best determined by referring to market transactions made in respect of comparable properties". Cf. Murray, J.F.N. Principles and Practice of Valuation, Commonwealth Institute of Valuers, Sydney, 1973, p. 106.

yield he could obtain by investing his capital resources in some other way, with an equal degree of uncertainty.

Unfortunately the complexity of the property market is such that neither of the above situations is likely to exist. Investors who seek an interest in property may be classified as either mortgage investors or equity (ownership) investors. As a broad principle the equity investor seeks to borrow some quantity of mortgage funds on the most acceptable terms. He supplies the balance of purchase capital as equity funds which he generally strives to minimise.[1] The equity investor seeks maximum advantage from the situation commonly termed leverage which, other things being equal, will bring the equity investor a higher yield on his investment than the mortgage investor on his.

Now, if a property investment is a combination of mortgage and equity parts the mortgage and equity capital contributions must represent to their investors the present worth of the benefits each will receive. Total property value, therefore, must be obtained by discounting at an overall rate which reflects each investor's aspirations. Such a capitalisation rate may be obtained via the following formulation:[2]

$$i_c = m(f - p.\ 1/s_n) + y\ .\ e \qquad 7.26$$

where m = ratio of maximum available mortgage to value

f = annual requirement for interest and amortisation of the mortgage

p = percentage of mortgage paid off at the end of the income projection period

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1. In some cases the question of gearing may be less simple. For example, the small investor may wish to limit his risks and his management input whilst getting a safe and sufficient return on his own funds plus his labour of management.

2. Kahn, S.A., Case, F.E. and Schimmel, A. Real Estate Appraisal and Investment, The Ronald Press Company, New York, 1967, p. 127.

$1/s_n$ = sinking fund factor at the equity rate of return

y = equity yield rate necessary to attract a purchaser

e = ratio of equity investment to value.

Total property value may then be expressed as:

$$cR = R/i_c = \frac{\beta\theta q}{i_c\,(q + \theta\alpha)} + \frac{\lambda q}{i_c} \qquad 7.27$$

where i_c = the capitalisation rate.

The shape of the curve will be maintained but of course the vertical axis will now alter to indicate total value. The same type of analysis may be carried out with total value as has been carried out with total revenue. Marginal value simply reflects the new scale and may be written as:

$$\frac{\partial cR}{\partial q} = \frac{1}{i_c}\left(\frac{\beta\theta^2\alpha}{(q + \theta\alpha)} + \lambda\right) \qquad 7.28$$

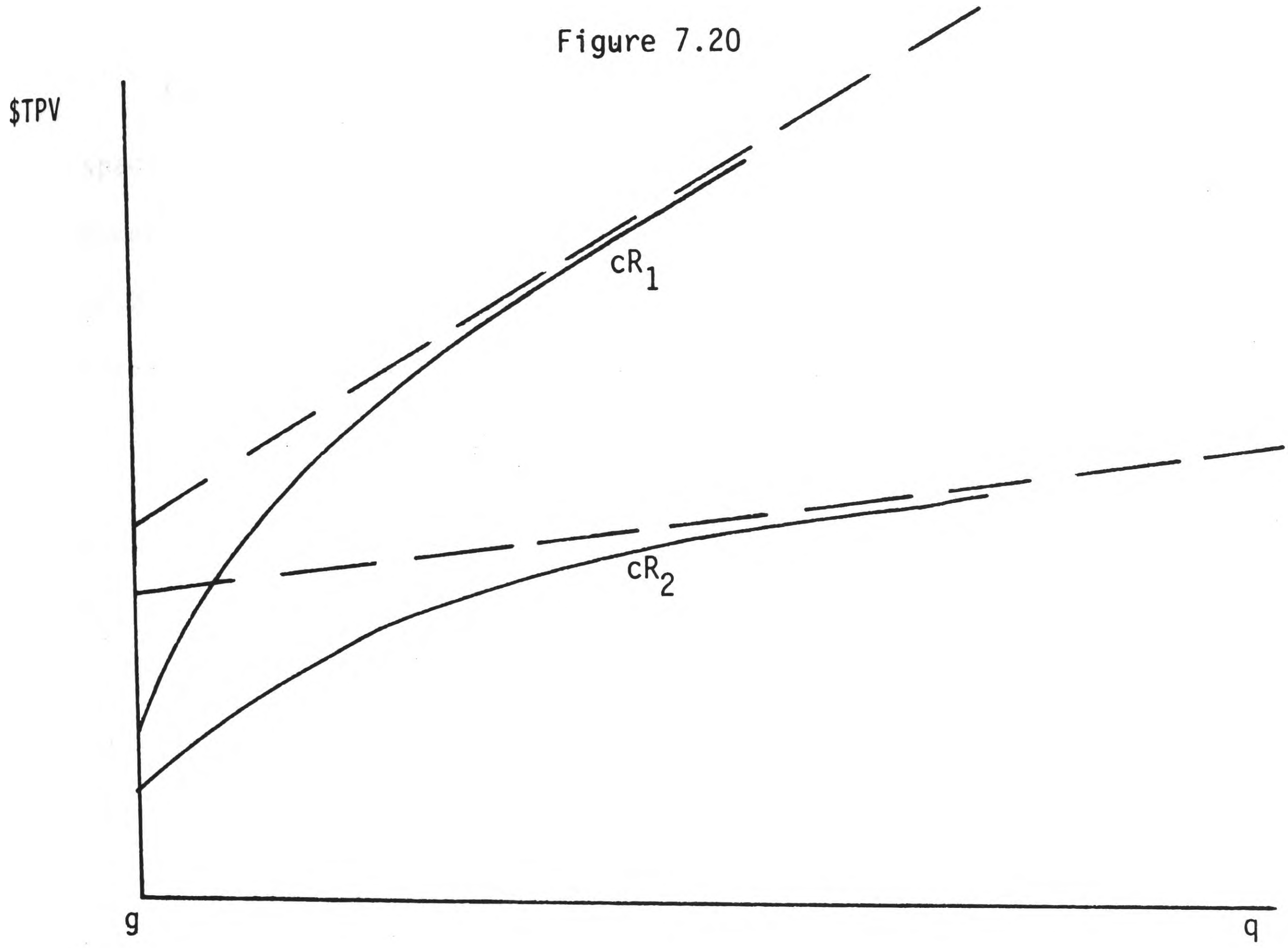
and the slope of the upper asymptote is:

$$\frac{\partial A}{\partial q} = \frac{\lambda}{i_c}$$

where A indicates the asymptote $R = \frac{\lambda q}{i_c}$

Now, how will this total value curve vary as the capitalisation rate varies. For example, suppose monetary policy enactments bring about a rise in the rate of interest, or, credit restrictions are created which reduce the m-ratio (the amount the equity investor can finance) in equation (7.26). An increase (decrease) in the discount rate will lower (raise) total property value and will reduce (increase) the slope. This is shown in the following diagram:

Figure 7.20



Here total property value has been decreased (increased) for any given level of development and marginal value has also been decreased (increased) i.e.:

$$\frac{\partial cR_1}{\partial q} > \frac{\partial cR_2}{\partial q} > \ . \ . \ . > \frac{\partial cR_n}{\partial q} \qquad 7.29$$

Of course the same argument applies if rent per square foot increases with height above ground floor level.

7.6 Conclusion

In Chapter six it was hypothesised that per unit floor space rents depend, amongst other things, on the degree of bargaining power between landlord and tenant. It was argued that if a lower modal distribution case exists then lower size category landlords will have relatively greater bargaining power than upper size category landlords. Consequently per unit floor space rents may be expected to decrease as size category increases.

That chapter established an explanatory basis for commercial floor space rents. However the task of how to transfer this notion (of bargaining power variation in the market for commercial floor space), to the problem of land value determination and capital/land substitution, still remained. The present chapter undertook a step in this direction.

To this end, then, the chapter was primarily concerned with ascertaining the manner in which the total revenue of a given property may be expected to vary as bargaining power and location vary. In the first instance an average rent function was established. Data from the Wollongong CBD were utilised in parameter estimates. Once the total revenue function was created its behaviour was examined by varying the assumptions with regard to bargaining power and location. The usefulness of this will be seen when these results, and the results of the following chapter, are combined in Chapter nine and Chapter ten to examine the influence of bargaining power on land value determination and capital/land substitution.

CHAPTER 8

THE VARIATION IN BUILDING REPLACEMENT COSTS

8.1 Introductory Statement

In order to be able to examine the manner in which site value may vary as bargaining power, or location (or other identifiable factors, if any, which are found relevant) vary, it is useful to be able to first examine the effects separately of such variation on each of revenue and cost. The previous chapter examined the revenue aspect. In this chapter we analyse variations in construction costs as bargaining power and location vary. In Chapter nine both sets of analysis will be combined.

Section 8.2 is concerned with the development of a cost function to be utilised in later manipulations. The literature on the variation in construction costs as the size of a project varies is relatively abundant. Use is made of this information to develop an abstract cost function. The function takes the form of a simple parabola whose vertex is displaced to the left of the cost/height origin.

Section 8.3 examines the manner in which this function behaves (variation in slope and height) as bargaining power and location vary. It is suggested that variations in construction of size categories are reflected in slope variations whereas variations in location are reflected in variations in height of the function.

Section 8.4 is concerned with using available data to test hypotheses advanced in the previous sections. Due to the restricted quality of the data the hypothesis testing is somewhat limited. For instance, in testing the general slope of the cost function a simple quadratic model is utilised. In general these statistical tests support the hypotheses advanced.

8.2 Development of Cost Function

Since building cost is influenced by a large number of variables it is difficult to describe a cost function which adequately explains how costs vary with building height. The impact on cost of a height increase will depend on the type, form and construction of the building. For instance, it will depend on the range of the height increase and whether the previous potential building height has been taken to its structural limitations: "Beyond a certain number of storeys the form of construction changes and costs usually rise. The change from load bearing walls to framed construction is often introduced when buildings exceed four storeys in height".[1] If the previous potential building height had not been taken to its structural limitations then the addition of an extra floor would not necessitate structural alteration. Thus the extra costs associated with increased height would depend only on the labour, material and financial components involved. Beyond the structural limitations, however, it could be necessary to change, for instance, from load bearing brick to reinforced concrete or structural steel. (Dunican has found that reinforced concrete is regarded as being cheaper than structural steel for the mainframes of multi-storey buildings.[2] Dunican found the saving to be 20 to 25 percent of the structural steel cost as opposed to the 10 to 20 percent saving suggested by Leon and Wajda).[3]

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1. Seeley, I. H. Building Economics, Macmillan, London, 1972, p. 30.

2. Dunican, P. "Structural Steelwork and Reinforced Concrete for Framed Buildings: Some Notes on Comparative Economics", The Chartered Surveyor, August, 1960.

3. Leon, G. and Wajda, R. L. "Economic Principles of Multi-storey Industralised Buildings", The Quantity Surveyor, Sept./Oct. and Nov./Dec., 1967.

Apart from changing structural materials, increased height implies that the sub-structural components (foundations) will be required to bear an increasing load on a given area (assuming θ does not change). At some point the load bearing capacity of the soil will be insufficient and will thus necessitate a change from strip or pad foundations to piled foundations. (The point at which this occurs will depend on the geological sub-structure of the area). When this point has been reached there will be a significant increase in costs.[1]

Vertical transportation systems tend to become increasingly expensive as building height increases. Costs increase sharply at the height at which installation of an elevator becomes necessary[2] but the cost impact may be distributed over a relatively large area. It has been suggested as a rule of thumb that ". . . one lift will adequately serve approximately 25,000 net square feet of office area".[3] As the quantity of floor space increases with height more lifts will become necessary thus creating a further sharp increase in costs. Furthermore, the taller the building then generally the faster the lift service required. Faster lifts imply higher costs. Table 8.1 shows the variation in lift speed, capacity requirements and costs as building height increases.

Apart from those components (above) which increase costs more than proportionately with height increases, there will be some components which increase costs directly with the quantity of floor space supplied (i.e. as height increases). For example, the cost of material components in wall, floor and ceiling finishes, electrical and plumbing fittings and so on . . . will depend directly on the quantity used. Air conditioning

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1. Seeley, op.cit., p. 28.

2. Turvey, op.cit., p. 17.

3. George, W.A. "Cost Planning", The Building Economist, Vol. 12, No. 3., 1972, p. 150.

TABLE 8.1

COST OF LIFT INSTALLATION

Application	Type	No. of Floors	Speed Ft per Min	No. of Passengers	Installation Cost $	Cost per Extra Floor $
Office Blocks Hotels etc. (Prestige)	High Speed Gearless (Traction)	20	650	25	75,000	1,960
Office Blocks, Hotels etc. (High Standard)	High Speed Gearless (Traction)	15	500	20	65,500	1,680
Office Blocks, Hotels etc. (Average Standard)	Mod Speed Geared (Traction)	10	350	15	43,300	1,590
Hospitals, Office Blocks (Average Standard)	Low Speed (Hydraulic)	6	125	10	24,832	1,550
Office Blocks, Residential (Average Standard)	Low Speed (Hydraulic)	3	75	10	15,750	1,350

SOURCE: CORDELL'S BUILDING COST BOOK (1974) P. 52.

costs in multi-storey buildings, which use the high pressure ducted systems, are generally regarded as varying directly with the area serviced (although each plant has an optimum servicing area).[1]

One would expect labour costs to increase directly as height increased since employment would be for progressively longer periods (the author found that the mean time for building completion in 18 projects whose completion date lay in the period 1970-1976 was 35 days per storey - with a standard deviation of 6 days). However, a study by a United Nations Research Team found that labour costs per floor decreased (up to the

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1. Cf. Newton, W. A. (ed.) Cordell's Building Cost Book and Estimating Guide, Cordell Newton Pty. Ltd., Sydney, June 1974, p. 51.

thirteenth floor after which costs increased for the final two floors due to finishing up processes) due to the learning process in carrying out repetitive tasks.[1]

There are further cost components which vary directly with the height of development. Since taller buildings have a longer gestation period the opportunity cost of funds invested in site acquisition will vary directly with the height of the project. Similarly, development finance is required in larger amounts and for longer periods as building height increases.

Finally, in overall development, there are a number of fixed charges such as site acquisition costs, architectural fees, building approval fees, and so on . . . which do not vary with intensity of development.

These statements, then, suggest two broad features of the building cost function:

(i) over particular ranges of output (i.e. particular height increases if we assume a given quantity of floor space, θ, per floor) some costs will show a relatively constant increase;

(ii) since some of the capital employed in a project is indivisible there will exist points of discontinuity in the cost function where costs increase more than proportionately to increases in height. This is shown in Figure 8.1.

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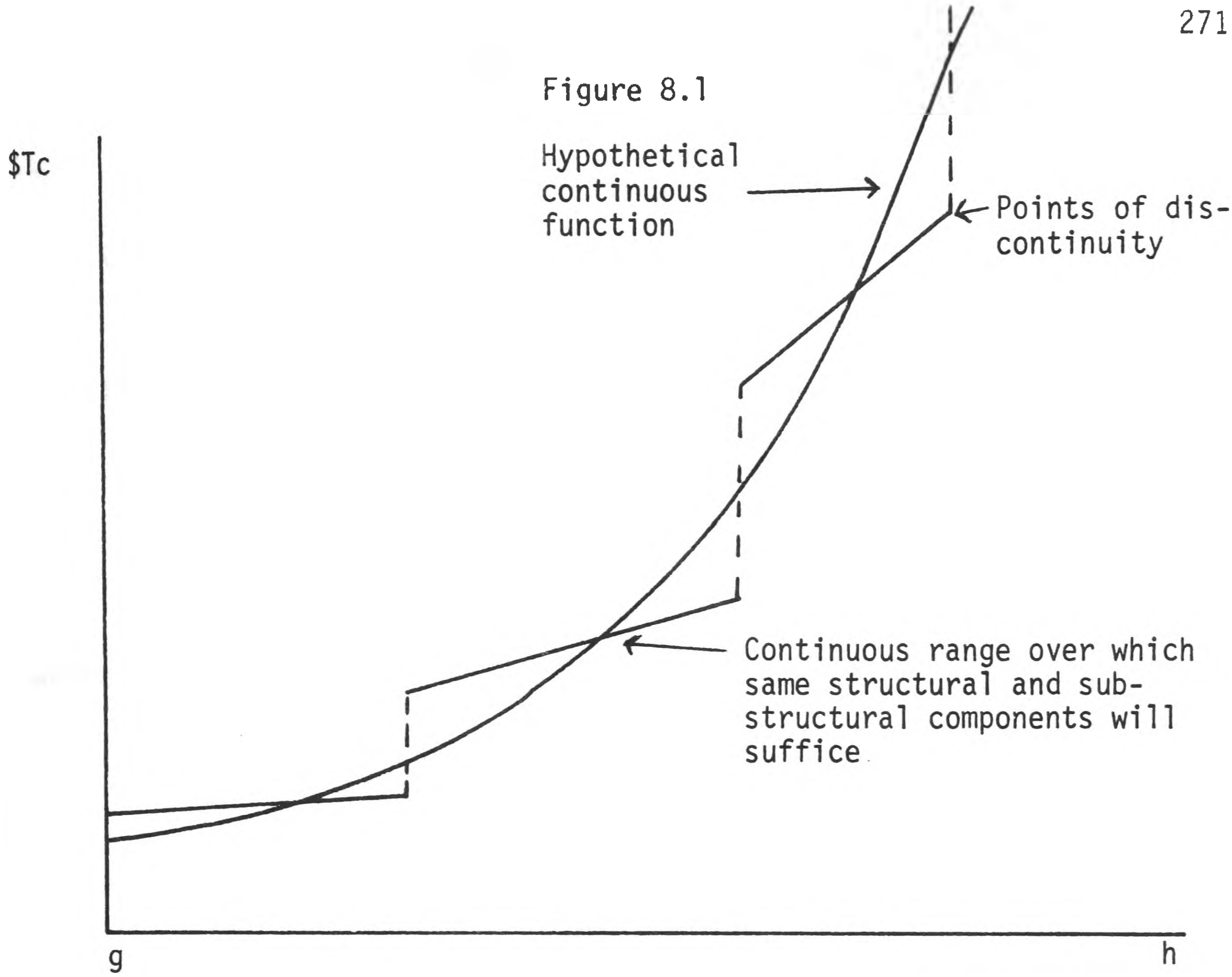
1. European Economic Community Research Project, Effect of Repetition on Building Operations and Processes on Site, United Nations Publication, U.N. Number ST/E.C.E./HOU/14, New York, 1965, pp. 39-43.



In the form represented by Figure 8.1, however, the building cost function is not amenable to abstract analysis. Suppose, now, that the sharp cost increases could be spread over a range of floors so that, although there were discontinuities (disproportionate increases in costs) at each floor level (height increase) the points, when joined together, took on the appearance of a smooth, continuous curve. This may be represented in a general fashion by a curve drawn through the midpoint of the continuous line segments in Figure 8.1. What this approach assumes, then, is that there is some form of compounding of costs as height increases. This is not an unrealistic assumption since a study by the Department of the Environment in Britain showed that as height increased above four storeys, building cost in office blocks increased fairly uniformly by about 2 percent.[1]

1. Seeley, op.cit., p. 30.

It may be assumed, then, that there are essentially three broad cost components in a developer's total development cost function:

(i) those fixed costs associated with development.

(ii) those variable costs which increase directly with the level (height) of development.

(iii) those variable costs which compound in some manner with the level of development. In the case mentioned above[1] the entire cost function would be represented by some exponential

$$Tc_h = Ae^{bh} \qquad 8.1$$

where Tc_h = the total cost for a given level of development

A = the cost of development up to the 4th storey

h = the height (above the 4th storey)

b = to be estimated

e = 2.71828.

However, if it can be assumed that this factor of disproportionate increase in costs depends on the previous level of construction costs (as in Seeley's case above) then it is also possible to express total costs as some parabolic function of the level of development, with its vertex displaced to the left of the cost/height origin (see Figure 8.4).[2]

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1. Ibid.

2. The conception of building cost as a quadratic function of height is not novel. Both Ferry, D. "The building and its Envelope", The Chartered Surveyor, March, 1966, and Bathurst, P.E. "The Building and its Envelope", Correspondence in The Chartered Surveyor, June, 1966, have presented formulae for the optimum number of storeys in a building. The formula devised by Ferry was -

$$N^2 = xf/2ws$$

where: N = optimum number of storeys (to be determined); x = roof unit cost/wall unit cost; f = total floor area; w = width of block; s = storey height. Bathurst produced the more complex formulation -

Footnote 2 continued from page 273.

$$N^2 = f(R + F - U)/\ 2wsc + 2sS + \frac{fskl}{2B}$$

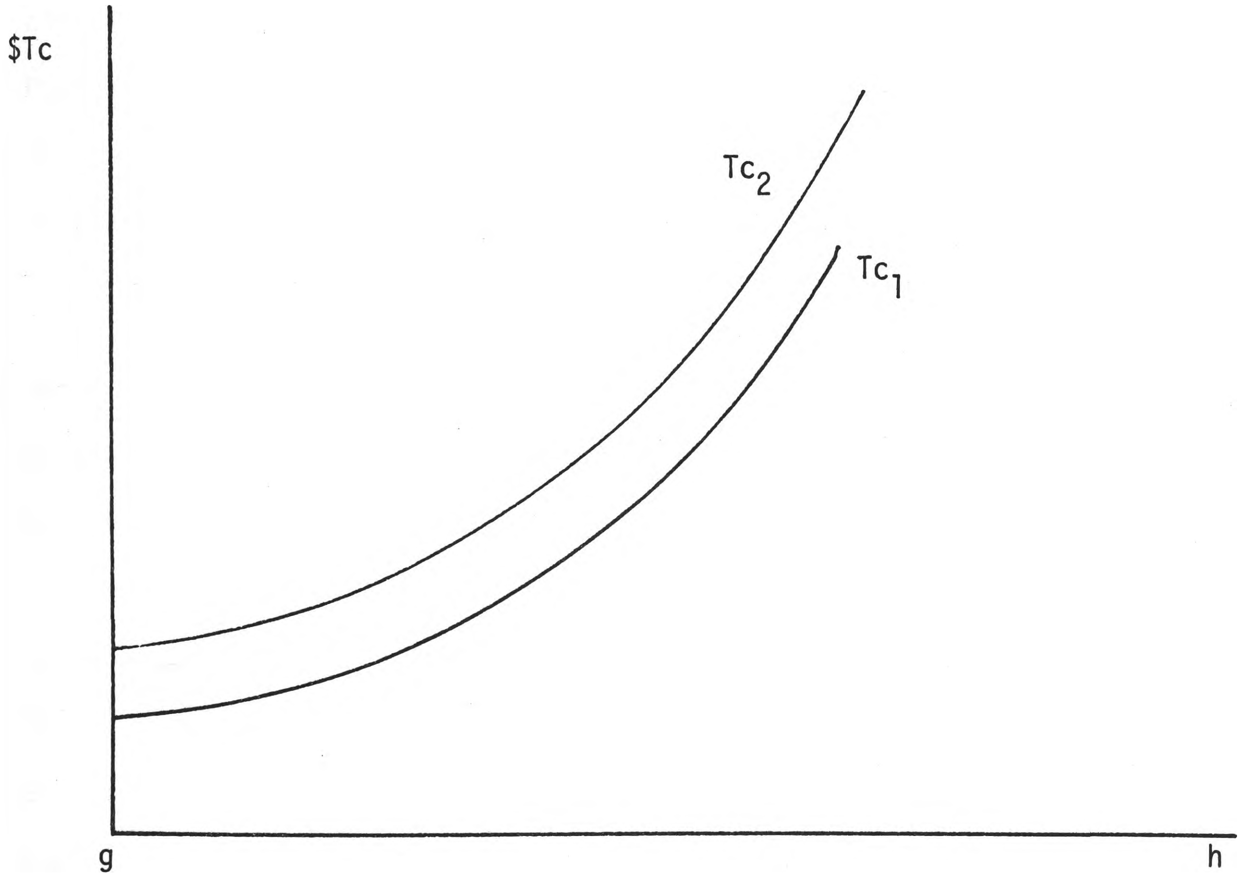
where: f = total area; w = width; s = storey height; k = strengthening factor of columns; c = unit cost of cladding; R = unit of roof (including beams); F = unit cost of ground floor slab; U = unit cost of upper floor slab (including beams); S = unit cost of staircase; L = unit cost of columns; B = floor area per column. Without further testing Singer, B. "Determining Optimum Development Intensity", The Appraisal Journal, July, 1970, p. 44, hypothesised a quadratic relationship between cost and height. His formulation was -

$$c = l + \frac{bg^2p}{f} - bgp + mg$$

where: c = development cost; l = land cost; g = number of gross square feet in building; b = basic unit construction cost for the building shell and systems; p = percentage increase in basic unit construction cost for each storey above ground level; f = average gross floor area per storey; m = the unit dollar amount of all development costs exclusive of land and basic building shell and systems.

This displacement to the left takes place in order to be able to distinguish - at the ground floor level - those cost changes which cause the entire cost curve to shift vertically and those cost changes which cause a pivoting of the curve. Let us consider the problems which may arise if the vertex is not displaced to the left of the cost/height axis. A change in site acquisition costs will cause the entire curve to shift vertically up or down. This is shown in the following diagram, but the case is discussed more fully in association with Figure 8.7 below.

Figure 8.2



Clearly in this case, in terms of indicating the cost changes at the ground floor level, it will not make any difference whether the vertex of the parabola is displaced to the left of the cost/height origin or not.

Let us suppose, now, that there is an alteration in the size of the floor space constant, θ per floor. For instance, suppose that there is a horizontal extension of building size. Now, since the extension is horizontal rather than vertical, there will be no alteration (in terms of supportive strength) in basic sub-structural components. Thus there will not be a more than proportional increase in costs, which would be the case with a vertical extension calling for an alteration in structural foundations (we are here considering changes envisaged at the planning stage). In fact Seeley has suggested that". . . certain fixed costs such as the transportation, erection and dismantling of site buildings and compounds for storage of materials and components, temporary water supply arrangements and the provision of temporary roads, may not vary appreciably with an extension of the size of a job and will accordingly constitute a reduced proportion of total costs on a larger project".[1] Furthermore, if a given vertical transportation system has not reached its capacity limitations, then some cost advantage may accrue through increasing the horizontal scale of a building.

Now, based on our previous assumption that the disproportionate increase in construction costs as height increases depends in some manner on the previous level of construction costs, then this and the above argument necessarily imply that, with an increase in θ, the rate of increase in total costs as height increases will decrease (i.e. marginal costs will decrease). This will be so since, at each and every floor level, a smaller building cost component is being subjected to the accelerated increase. Thus there will be an outward pivoting of the curve as shown in the following diagram (this is also further discussed in relation to Figure 8.5 and 8.6 below). As can be seen in this diagram, if the vertex is aligned with the cost/height axis then the diagram does

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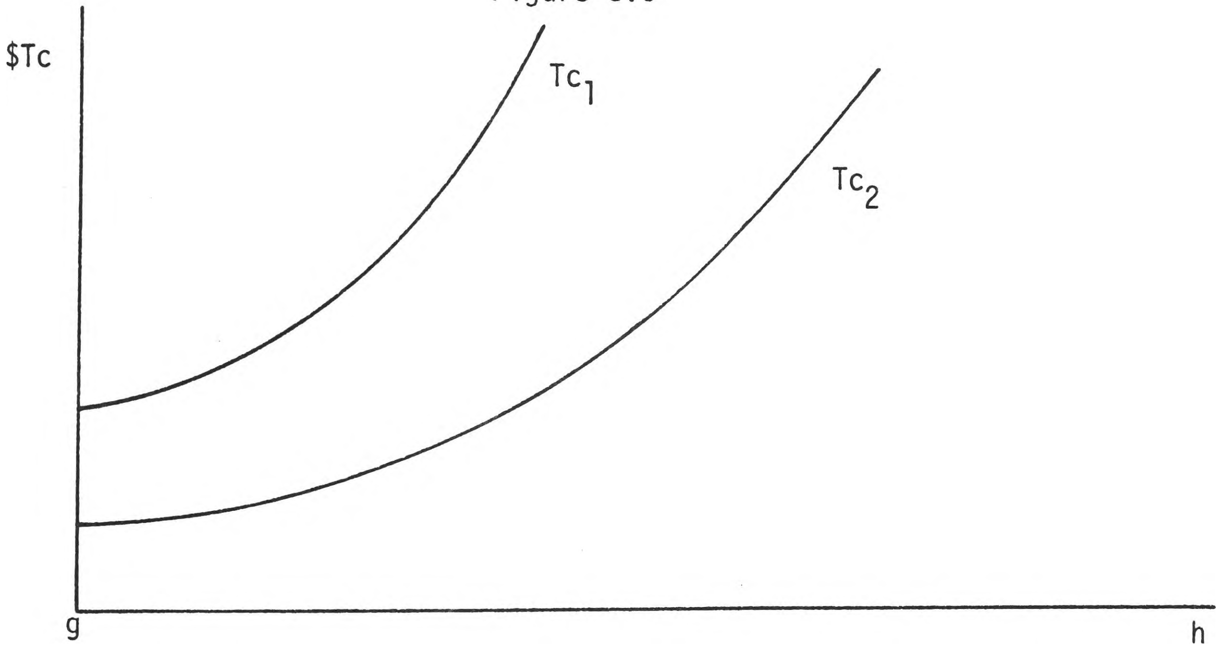
1. Seeley, op.cit., p. 21.

2. With vertical expansion it is supposed that the more than proportionate increase in costs will more than offset any decrease in per unit costs arising from the above factors.

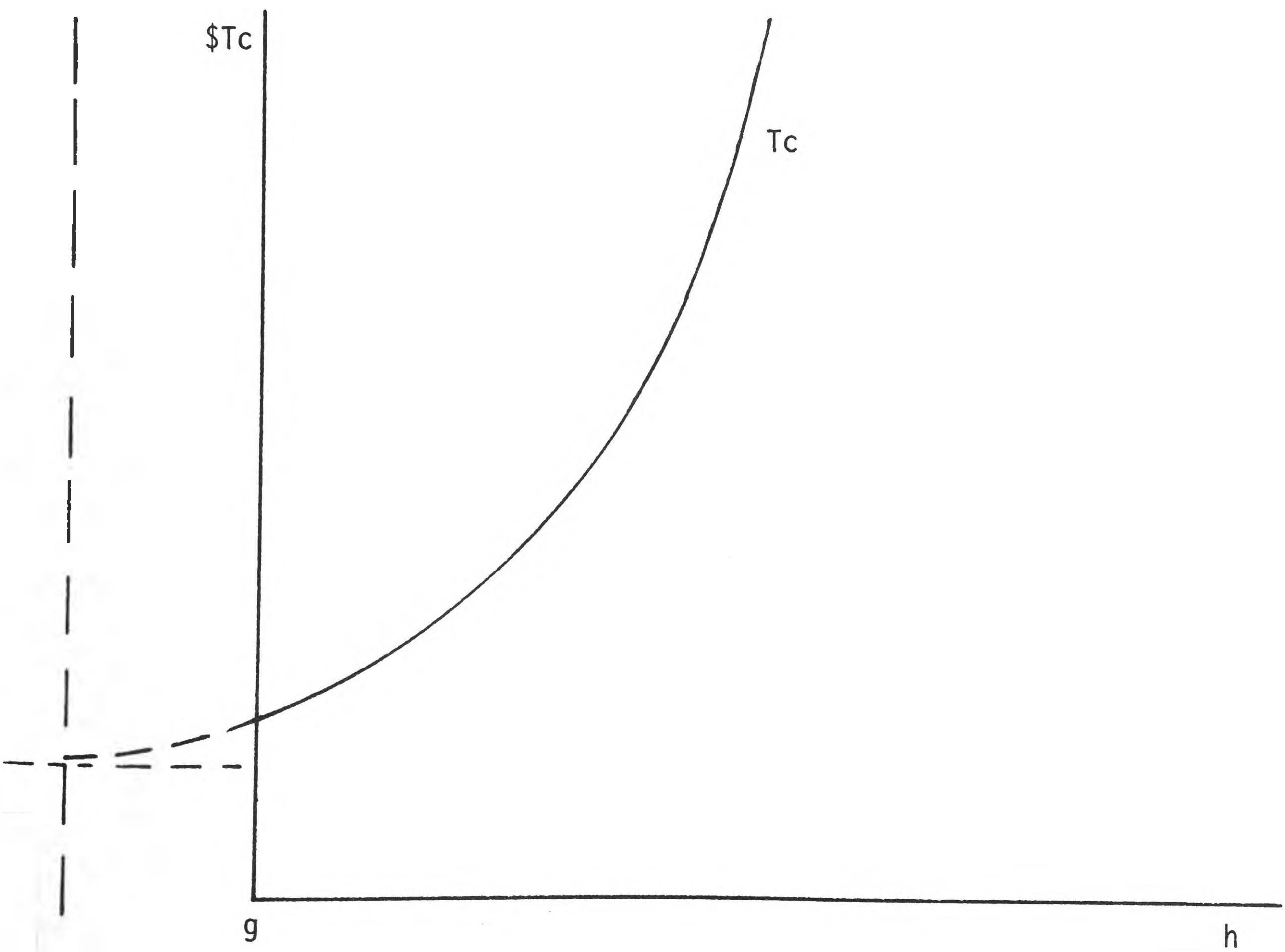
not reflect cost changes, associated with an alteration in θ, at the ground floor level. So that such cost changes at the ground floor can be demonstrated the vertex is displaced to the left of the cost/height origin.

Figure 8.3



In that case each aspect of development cost may be distinguished, for example

Figure 8.4



$$Tc = Fc + Of + Cch\theta + (\theta(h-1))\ Pu\ (h-1)\ Pc \qquad 8.2$$

where Tc = total development cost

Fc = site acquisition costs plus other fixed changes. Site acquisition costs may be expected to be overwhelmingly the major fixed cost here.

Cc = constant costs per square foot of floor space

h = the total quantity of floor space produced

(h-1) = the quantity of floor space produced at the previous level of development

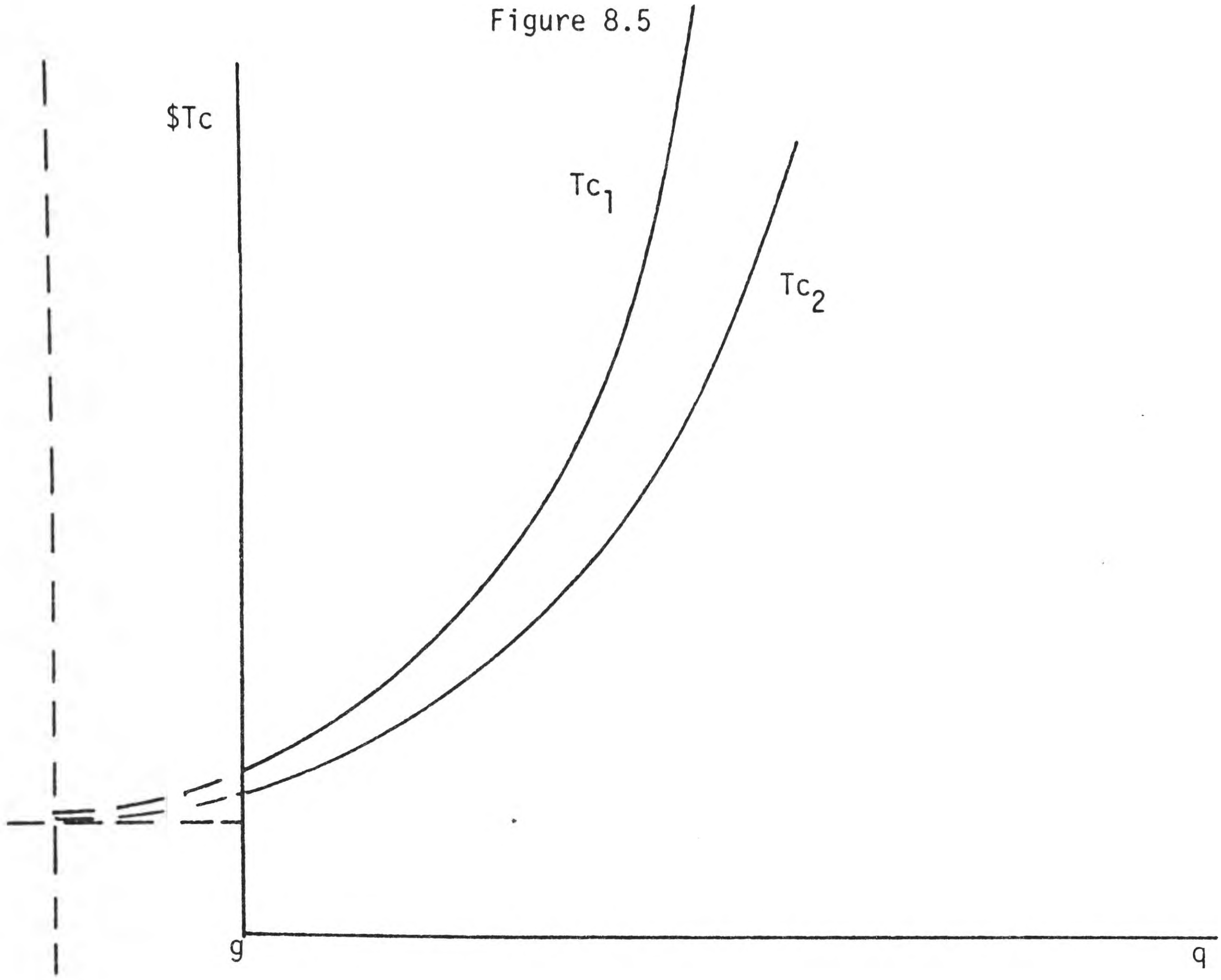
Pu = the per unit costs at the previous level of development i.e. $(\theta(h-1))Pu = Tc'-1$ where $Tc' = Tc - Fc$

(h-1)Pc = the percentage of Tc-1 added to costs as height (h) increases. For example, suppose the constant percentage, Pc, is 0.1%, then the costs associated with a 5 storey development would be Fc + Ccq plus 0.4% of the costs of a 4 storey development on the site.

8.3 Movement of Cost Function

Suppose the floor space constant, θ, is allowed to increase. How will this affect the cost function? Seeley points out that increasing the quantity of floor space on each floor will bring an overall reduction in per unit costs. Since production cost variations will have no effect on the fixed (site) cost component there will be a pivoting downwards on the axis as shown in Figure 8.5 (i.e. the parabola opens outwards at a faster rate).

Figure 8.5



Here, although marginal costs are increasing in both cases, marginal cost will be greater in the first case, i.e.

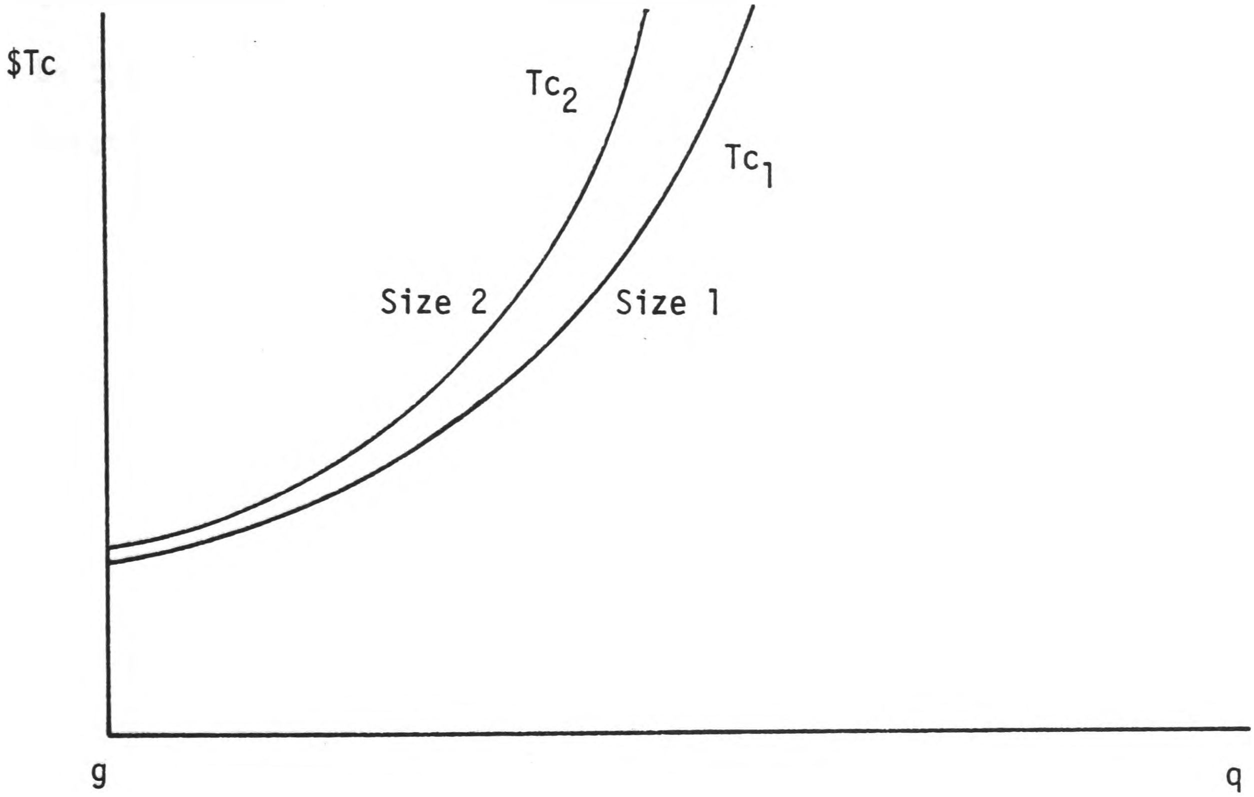
$$\frac{\partial Tc_1}{\partial q} > \frac{\partial Tc_2}{\partial q} \qquad 8.3$$

where, restating equation (6.18) in terms of q and differentiating we have

$$\frac{\partial Tc}{\partial q} = Cc + \frac{2q\ Pu\ Pc}{\theta} - 2Pu\ Pc$$

Now, hold θ constant and ascertain the effect on the cost function if the developer decides to supply space to either the upper or lower size categories. If the decision was to supply space in the lower size categories then there would be some increase in production costs due to the extra labour and material costs of subdivision (partitions, facilities, accessways, etc). As suggested in an earlier chapter, there may also be some loss of floor space in each floor due to subdivision. This plus the cost of subdivision wouldresult in a higher per unit cost for the variable component. The fixed component would not alter so that the curve would pivot upwards slightly on its axis as shown in Figure 8.6. Since all preceding potential development intensities are more costly, marginal cost is greater in the lower size categories.

Figure 8.6



Here:

$$\frac{\partial Tc_1}{\partial q} < \frac{\partial Tc_2}{\partial q} < \ . \ . \ . \ < \frac{\partial Tc_n}{\partial q} \qquad 8.4$$

where 1, 2 . . . n represents decreasing size categories.

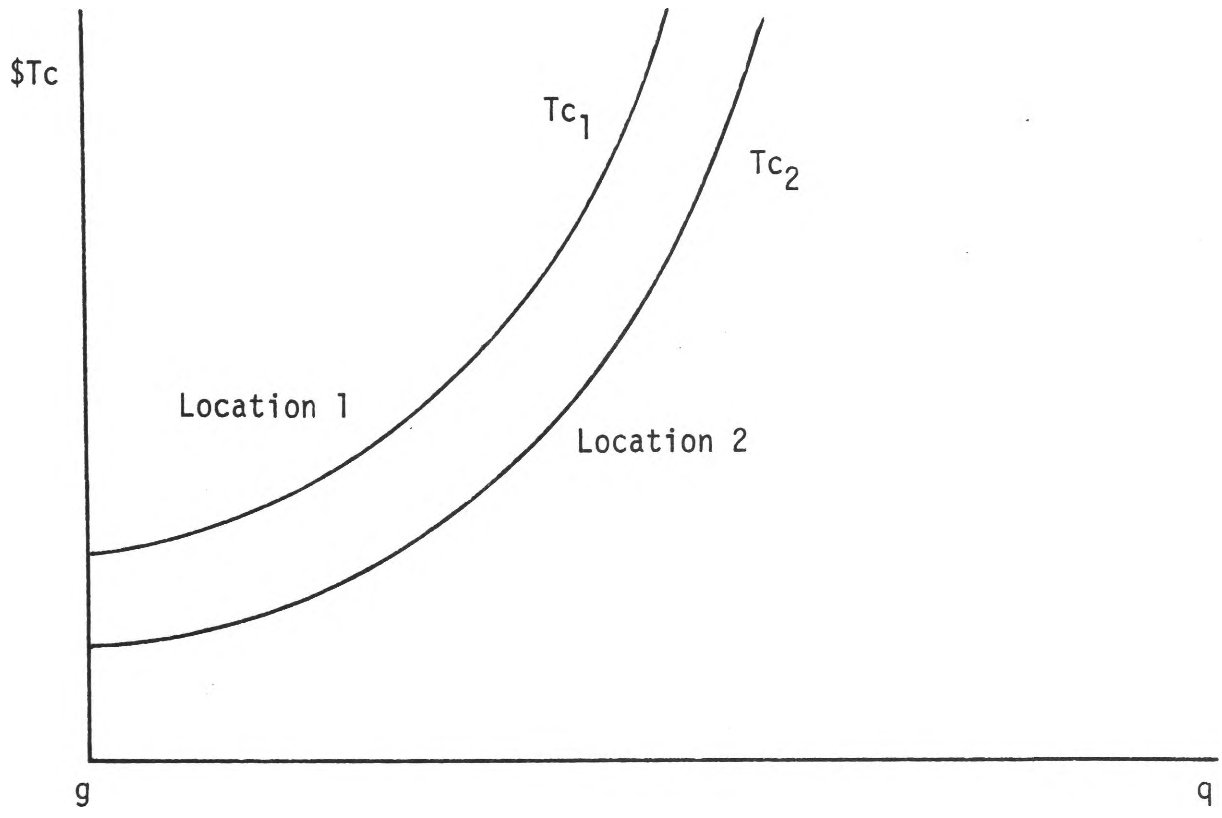
In considering the variation of development costs as distance from the PLV site increases the analysis is simplified by assuming

(i) a uniform geological sub-structure throughout the central city.

(ii) a constantly sized site as distance from the PLV increases (if a constant proportion of site is covered by the building then θ is also constant).

Land value theory holds that, in these circumstances, the value of the site will decrease with distance from the PLV site (cf. Chapter one above). Therefore as distance from the PLV site increases the entire cost curve will be shifted downwards as shown in Figure 8.7. Marginal costs will be the same in each case since construction costs will be unaffected by location within the CBD.[1]

Figure 8.7



i.e. $$\frac{\partial Tc_1}{\partial q} = \frac{\partial Tc_2}{\partial q} = \ldots \frac{\partial Tc_n}{\partial q} \qquad 8.5$$

where 1, 2 . . . n represents locations increasingly distant from the PLV site.

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1. Although interest is being lost on a smaller quantity of funds required for site acquisition the difference in slope may be expected to be negligible.

As the size of the site varies (and hence as θ varies) the curve may move up or down. (Variation in size of site is given further consideration in Chapter ten).

8.4 Tests of the Hypotheses

Cost and other data were obtained for 23 projects whose primary structural material was reinforced concrete, which was located in Sydney and which ranged from 4 to 31 storeys. Less useful information on another 13 projects was obtained from published material.[1] The published data had projects whose completion data ranged from 1960 to 1966 whereas the data collected by the author had completion dates ranging from 1970 to 1976. Although a deflator was used in an attempt to make the data comparable the data were still far from satisfactory since there was no way of taking account of differences in architectural design and differences in structural materials (the construction material in the published data was unknown).

Nonlinear regression analyses were carried out on the data. The results are summarised in Table 8.2. Generally the data were available only in the form of costs per square foot for a particular building height. Therefore the hypothesis on the precise form of the compounding factor could not be tested. The analyses were carried out using a simple quadratic model of the form

$$Tc = dh^2 + jh + o \qquad 8.6$$

where d, j and o are parameters to be estimated.

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1. Archer, R.W. "Market Factors in the Redevelopment of the Central Business Area of Sydney, 1957-1966", in Troy, P.N. (ed.) Urban Redevelopment in Australia, Urban Research Unit, ANU Canberra, 1967. Some of the projects in this data did not have the floor space completely specified, these were excluded as wasthe one project whose completion date fell prior to 1960. A major problem with both sets of data was that architectural design was unknown. A further problem with the published data was that the structural material was unknown.

In view of the unrefined state of the data the explanation provided by the quadratic model was generally quite good. In equation 1 (Table 8.2) when there were 36 observations the quadratic model "explained" 58 percent of the variation in the building cost data, and the regression was significant at the .01 level. Unfortunately the coefficients were

TABLE 8.2

COST VARIATION

Eqn. No.	R^2	F	N	Intercept	h-term	h^2-term
1	0.58	22.65	36	17.70	+0.58 (S_e=1.01)	+0.02 (S_e=0.03)
2	0.57	23.41	36	12.47	+1.34 (S_e=0.28)	
3	0.59	23.82	36	17.37	+1.36 (S_e=0.27)	-0.001S(S-term) (S_e=0.0001)
4	0.72	25.31	23	22.95	-0.41 (S_e=1.06)	+0.053 (S_e=0.03)
5	0.97	29.89	5	22.02	-0.9 (S_e=1.92)	+0.09 (S_e=5.81)
6	0.98	47.19	5	68.13	-5.45 (S_e=2.09)	+0.169 (S_e=0.05)
7	0.97	28.65	5	13.33	+0.73 (S_e=0.22)	-0.007 (S_e=0.004)

not quite as satisfactory. Only the intercept coefficient was significant at the .05 level. Although the hypothesis that the coefficient in the h^2 term does not differ significantly from zero cannot be rejected at the .05 level, this does not necessarily imply that the hypothsis should be accepted. However it was tempting to test a two variable linear model the results of which are shown in Equation 2. Here, although the regression was significant at the .01 level and both of the coefficients were significant at the .01 level, the explained variation was reduced by 1 percent. The rather good results with a linear regression may be due to an insufficiently wide range being available in the independent variable. Table 8.3 shows the distribution of project heights in the sample. Here it may be observed that more than half of the projects were between 10 and 20 storeys in height, while about 80 percent of the projects were between 10 and 25 storeys in height.

TABLE 8.3

Number of Storeys	Relative Frequency	Cumulative Frequency
< 10	.08	.08
10 < 15	.28	.36
15 < 20	.25	.61
20 < 25	.25	.86
25 < 30	.11	.97
$\geq$ 30	.03	1.00

Amongst the factors affecting the variation in cost it was previously suggested that the quantity of floor space per floor, θ, would be important. A brief test of this hypothesis was carried out using the 36 observations (unfortunately net floor space had to be used since gross floor space was not available in every case) in a 3 variable linear model. The results are shown in Equation 3 (Table 8.2). Here it may be seen that the coefficient of determination increased from .57 to .59. The size coefficient was significant at the .10 level.

The 23 projects from which data were extracted for Equation 4 were all constructed with reinforced concrete. It is not known whether it was this or the fact that 14 of the 23 observations were supplied by 3 developer/architects (hence minimising differences in estimating techniques), but the results were remarkably better than in the larger sample case (one suspects that it was some combination of both factors).

The regression was, once again, significant at the .01 level but the variation attributable to the regression increased to 72 percent of the total variation. The coefficients of the intercept and squared terms were significant at the .05 level, but the coefficient of the linear term was not significant.

For equations 5 and 6 the data were in a more refined state, that is, each set of observations was obtained from a single developer. Unfortunately the number of observations is too small to permit any kind of generalisation. Nevertheless it is interesting to note the vast improvement in explained variation in each case. In equation 5 the project height ranged from 8 to 24 floors (the levels were, in fact, 8, 14, 17, 23 and 24 floors) while in equation 6 the range was from 11 to 31 floors (11, 12, 13, 26, 31). In both cases more than 96 percent of the cost variation was explained by the quadratic model. In equation 6 all of the coefficients were significant at the .05 level. In equation 5 the coefficients of the intercept and squared terms were significant at the .10 level (but the coefficient of the linear term was not significant).

A final set of observations was obtained from Cordell's Building and Estimating Guide. A regression analysis (Equation 7) of this data showed that the axis of the parabola was parallel to the height axis so that building costs per square foot were increasing at a decreasing rate as building height increased. This result directly contradicts the results previously established.[1]

8.4 Conclusion

This chapter set out to develop a building cost function which could be utilised in the following chapter to analyse the influence of bargaining power and locational variations on site value. A hypothetical building cost function was developed using information from the literature. For analytical purposes the cost function was conceived of as a smooth parabolic curve. The behaviour of this function under differing assumptions of supplying space in various size categories and at various locations was then considered. It was suggested that the height of the function would depend on site acquisition costs and the slope of the function would depend on the size category supplied. The final part of the discussion was concerned with testing the hypotheses put forward in the first two sections. The tests were somewhat restricted due to the relatively reduced quality of the information available. For instance information as to the precise method of compounding costs was not available. A simple quadratic model was therefore utilised to test for curve structure and the statistical tests confirmed the hypothesised shape of the cost function. In general the empirical analysis of section 8.3 tended to support the hypotheses advanced in the initial sections.

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1. The Cordell data provides a guide for feasibility studies and for which some 'standard' design and finish is adopted. The 'Guide' provides cost estimates for particular ranges of building height. The data for equation 7 was extracted by taking the median height between the previous maximum height and the new maximum height and applying the standard cost. The results were substantially the same when the maximum height in each category was applied. (Cf. Newton, op.cit., p. 44). In equation 7 the regression was significant at the .01 level as were the intercept and linear coefficients. The coefficient of the squared term was significant at the .10 level. The writer corresponded with Cordell and Newton noting the conflicting results. Eighteen months later a reply has yet to be received. The writer can offer no explanation for the contradictory results, but the results suggest that, with large building heights, there may tend to be considerable differences between actual costs and estimated costs if use is made of 'Cordell's Guide'.

CHAPTER 9

SITE VALUE DETERMINATION

9.1 Introductory Statement

9.2 Maximum Site Value

9.3 Bargaining Power and Site Value

9.4 Vacancy Rates, Location and Site Value

9.5 The Alternative Proposition on Rent Variation and its Effect on Site Value

9.6 Site Value and the Variation in Size of Site

9.7 Conclusion

9.1 Introductory Statement

This chapter synthesises the many strands of analysis in chapters six through eight in order to answer one of the basic problems of the current piece of research viz. that of land value determination in the central business district, or, more specifically within areas of similar locational desire in the CBD. The analysis is considered in five parts. The basis of the entire discussion is presented in section 9.2 which considers the concept of a normal (profit maximising) level of development and the manner in which this implies a maximum site value for a given use.

Throughout Part III the discussion has been concentrated on the manner in which bargaining power variation can alter the revenue and cost functions. In section 9.3 these analyses are combined to ascertain the manner in which maximum site value will vary as bargaining between landlord and tenant varies. The abstract analysis unfolds some interesting results which, at least superficially, would appear to be unrelated to bargaining power as it is defined here. For instance, one implication of the analysis is that if upper size category landlords have a relatively small degree of bargaining power, then the central business district will have a relatively low sky profile (that is, low by comparison with the profile that would exist in the absence of the 'abnormality').

Section 9.4 considers two important variables within the analytical framework viz. vacancy rates and location (not within an SLD area, but in SLD areas of varying distance from the PLV site). It is suggested that an equal increase in vacancy rates across the board will decrease land value but will leave the normal level of development (the profit maximising level of capital/land substitution) unchanged. As an aside a diagrammatic demonstration of the effect of variations of the vacancy rate between upper and lower floors is undertaken. This indicates that (a) an increase in upper floor vacancies implies a decrease in site value and a decrease in the optimum level of capital/land substitution while (b) an increase in lower floor vacancies also implies a decrease in site value, but it implies an increase in the optimum level of development (under the assumptions of the model).

The discussion in this section also indicates that, in conformity with conventional land value theory, site value will decrease as distance from the PLV site increases. The discussion also suggests that (in a given period) there will be a falling sky profile towards the periphery of the CBD.

In Section 9.5 a discussion is undertaken on the alternative proposition that per unit rents increase with height above ground floor level. With respect to the site value function it is suggested that site value varies with output in much the same manner as previously (that is, with respect to the proposition that rents decrease with height above ground floor). Similarly it is argued that the results pertaining to bargaining power and vacancy rates remain as previously established. With respect to location and site value it is suggested that, if there is a decline in the relative desire for upper floor location as distance from the PLV site increases, then land values and the sky profile will fall towards the periphery.

The final section returns to a problem first raised in Chapter three. In that chapter it was shown that, in the Wollongong CBD, the relationship between site value and variation in size of site may be positive, negative, or there may be no relationship. This was shown not to agree with 'conventional' land value theory. However, using the model developed throughout the thesis it is demonstrated that it is possible to have a positive, a negative, or no relationship between per unit value and size of site.

9.2 Maximum Site Value

Associated with every 'highest and best' use, or combination of uses, there will, of course, be a highest and best, or normal[1] (optimum) level of development. This highest and best level of development will produce the maximum site value for a given use.

For the moment assume that the property market is "perfect". Amongst other things this supposes perfect knowledge and equal bargaining power (i.e. no one landlord, or group of landlords, or tenant, or group of tenants may influence price). In that situation a landlord/developer may be expected to make normal profits. Elementary economic theory suggests that the highest and best level of development occurs where marginal revenue and marginal cost are equated, that is where

$$\frac{\partial cR}{\partial q} = \frac{\partial Tc}{\partial q} \qquad 9.1$$

and at this point, under these conditions, the revenue and cost curves will be tangential as shown in the following diagram.

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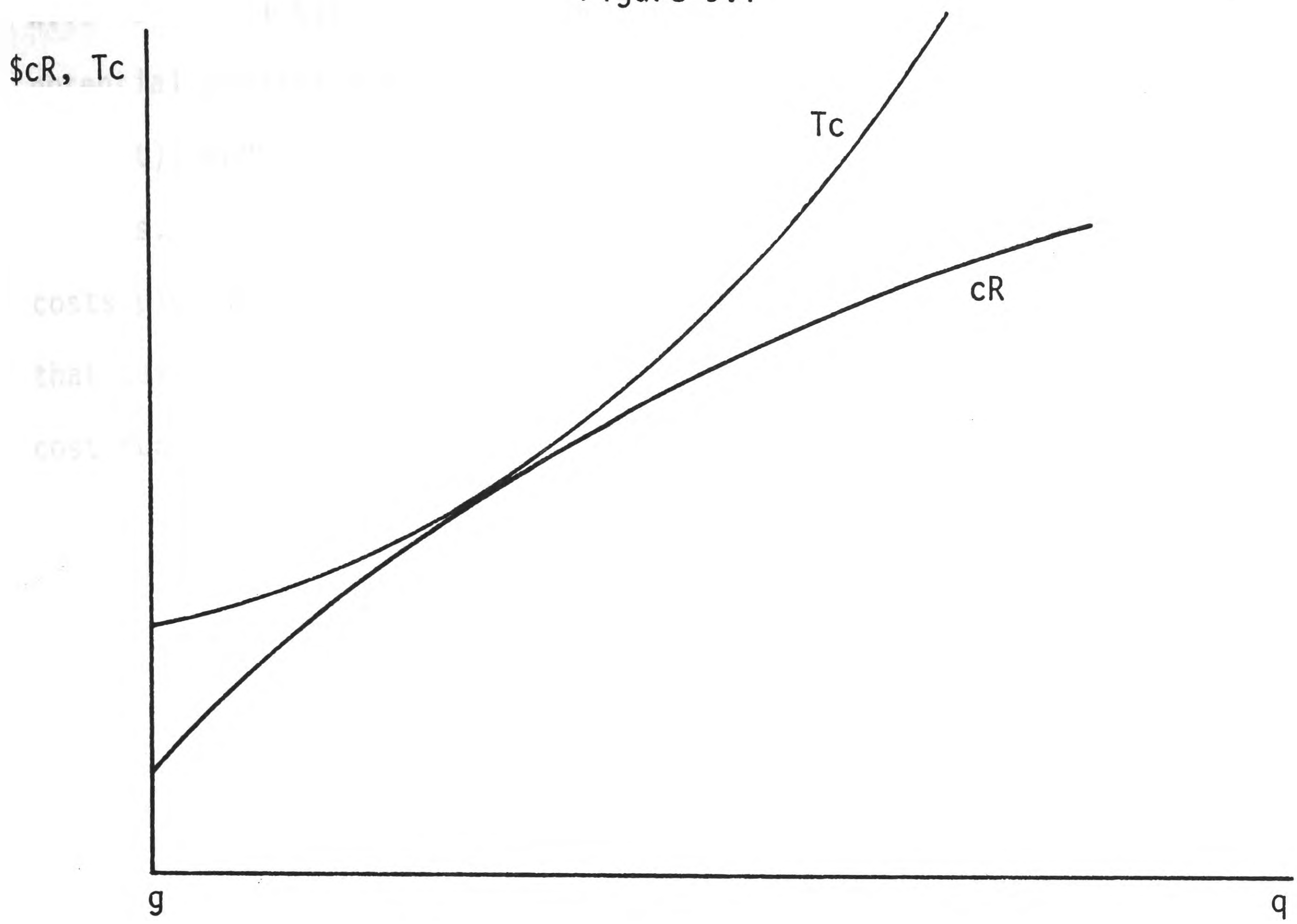
1. Normal in the sense that it is a profit maximising level of development and profit maximising behavour is taken as the norm.

Figure 9.1



In this particular situation site value may be simply equated with site acquisition costs. These acquisition costs are fixed irrespective of the site development.

On the other hand site value may vary with the level of development. In effect this suggests that site acquisition costs may be greater than, equal to, or less than site value. To better understand this position relax the assumption of a "perfect" market and suppose that the seller (of a site) is not fully apprised of the facts on the development potential of the site. To take an extreme case suppose that the seller believes that a one storey retail establishment represents the best use of the site, whereas the highest and best use is in fact represented by a ten storey mixed use development. If the seller values the site according to his erroneous belief he will be selling the site 'cheaply'.

If the developer is fully aware of the development potential, then this will lead to a situation in which development costs will be less than potential capitalised revenue over some range of development intensities (output), and the developer will be capable of making supernormal profits. In effect site value will be here equated with site acquisition costs plus the difference between capitalised revenue and costs.[1] In that case, if site acquisition costs are excluded from the development cost function, site value may be written as

$$Sv = cR - (Tc - Fc)$$

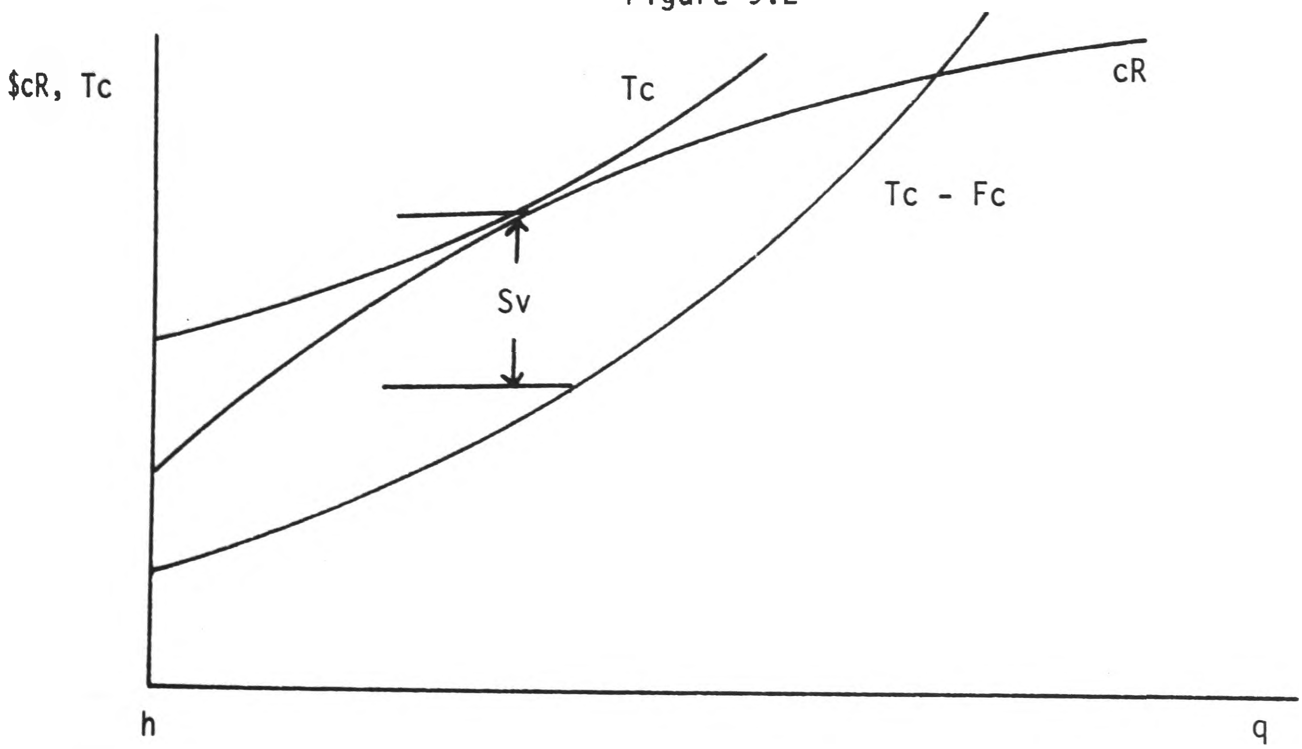
$$= \frac{\beta\theta q}{ic(q+\theta\alpha)} + \frac{\lambda q}{ic} - Fc - Ccq - \frac{Pc\ Pu\ q^2}{\theta} + 2\ Pc\ Pu\ q$$

$$- \theta\ Pc\ Pu + Fc \qquad 9.2$$

$$= \frac{\beta\theta q}{ic(q+\theta\alpha)} + \frac{\lambda q}{ic} - Ccq - \frac{Pc\ Pu\ q^2}{\theta} + 2\ Pc\ Pu\ q - \theta\ Pc\ Pu$$

This may be shown graphically as follows (Figure 9.2):

Figure 9.2



1. Normal in the sense that it is a profit maximising level of development and profit maximising behaviour is taken as the norm.

Thus, site value is here equated with site acquisition costs plus those supernormal profits which have been created by one party's superior knowledge of the site's development potential. Essentially such supernormal profit is an income transfer between the developer and the existing landowner.[1]

From Equation 9.2 it may be said that site value (Sv) is some quadratic function of q. The change in site value with respect to the level of development may be written as:

$$\frac{\partial Sv}{\partial q} = \frac{i}{ic}\left(\frac{\beta\theta^2\alpha}{(q+\theta\alpha)^2} + \lambda\right) - Cc - \frac{2\ Pc\ Pu\ q}{\theta} + 2\ Pc\ Pu \qquad 9.3$$

Site value rises to some maximum since the second derivative

$$\frac{\partial^2 Sv}{\partial q^2} = \frac{-2\beta\theta^2\alpha}{ic(q+\theta\alpha)^3} - \frac{2\ Pc\ Pu}{\theta} \qquad 9.4$$

is negative. Looking at Equation 9.2 it may be seen that when q is very small, say close to $-\alpha\theta$ but $>-\alpha\theta$ (e.g. at ground floor level) Sv is very small. As height increases so also does site value. However as q becomes very large Sv takes on smaller and smaller values. The general shape of this curve may be shown as in Figure 9.3. The level of development at which maximum site value is obtained (q_{max},Sv_{max}) may be ascertained by setting

$$\frac{\partial Sv}{\partial q} = 0$$

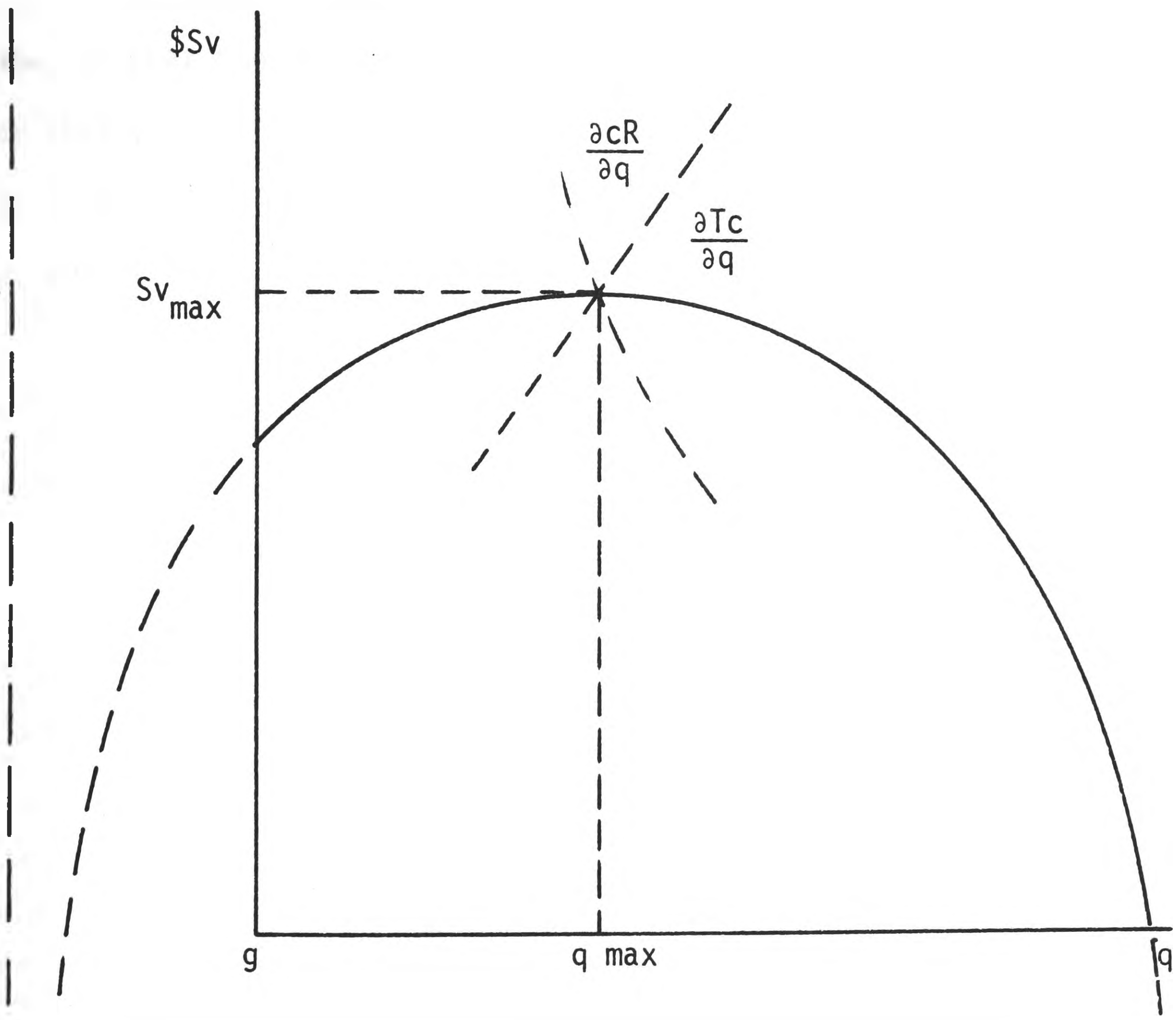
from which we have

$$\frac{1}{ic}\left(\frac{\beta\theta^2\alpha}{(q+\theta\alpha)^2} + \lambda\right) = Cc + \frac{2\ Pu\ Pc\ q}{\theta} - 2\ Pu\ Pc \qquad 9.5$$

---

1. Dr. Brian Bentick enabled the elimination of superfluous variables in the original analysis by bringing this point to the writer's attention.

Figure 9.3



and solving for q. In its present form Equation 9.5 is a cubic equation and may be solved either by Newton's method[1] or by trigonometric substitution.[2]

It is interesting to note the manner in which site value varies with development. At any point up to (q_{max}, Sv_{max}) the site is being underutilised - is not being put to its highest and best use - and hence the maximum value is not being extracted from the site. At any point beyond (q_{max}, Sv_{max}) the site is overdeveloped and part of the income which should be attributable to the land is being utilised in the servicing of the building.

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1. Cf. Purcell, E. J. Calculus with Analytic Geometry, Appleton - Century - Crofts, New York, 1965, pp. 161-163.

2. Cf. Birkhoff, G. and Maclane, S. A Survey of Modern Algebra, Macmillan, New York, 1965, pp. 90-91.

9.3 Bargaining Power and Site Value

Now, in what manner may site value vary as bargaining power varies? Suppose that a lower modal distribution (LMD) case prevails so that tenants in the upper categories enjoy a relatively greater bargaining power. Whether site value increases or decreases as development takes place in the larger size categories will depend on the degree of bargaining power and therefore on the relative movements of the cost and revenue curves. If the lower size category (LSC) landlords tend to be in a very strong bargaining position relative to their upper size category (USC) counterparts then the relative movement will tend to be greater in the revenue curve so that site value will tend to decrease as size category increases. This is shown in the following diagram.

Figure 9.4

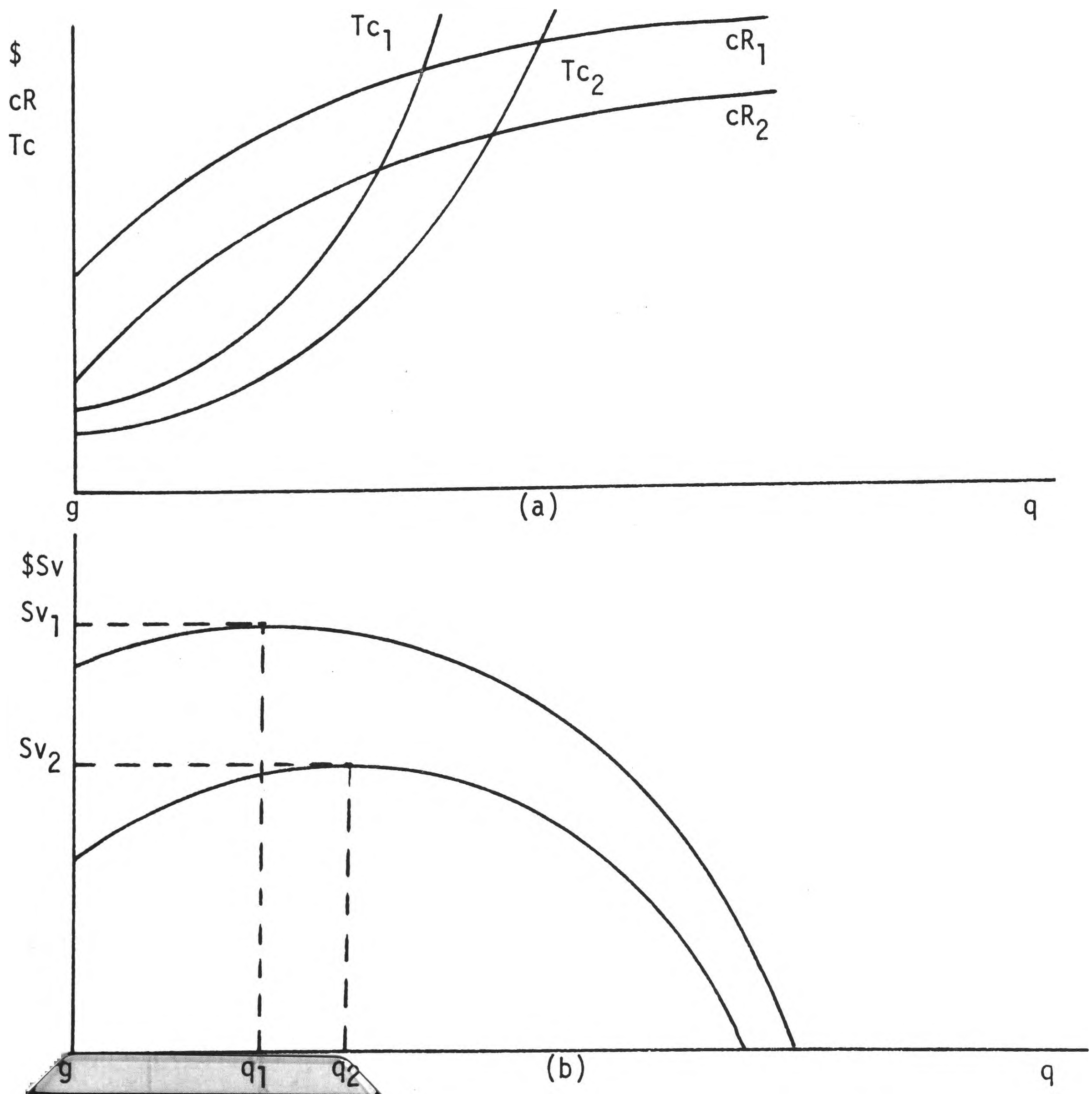
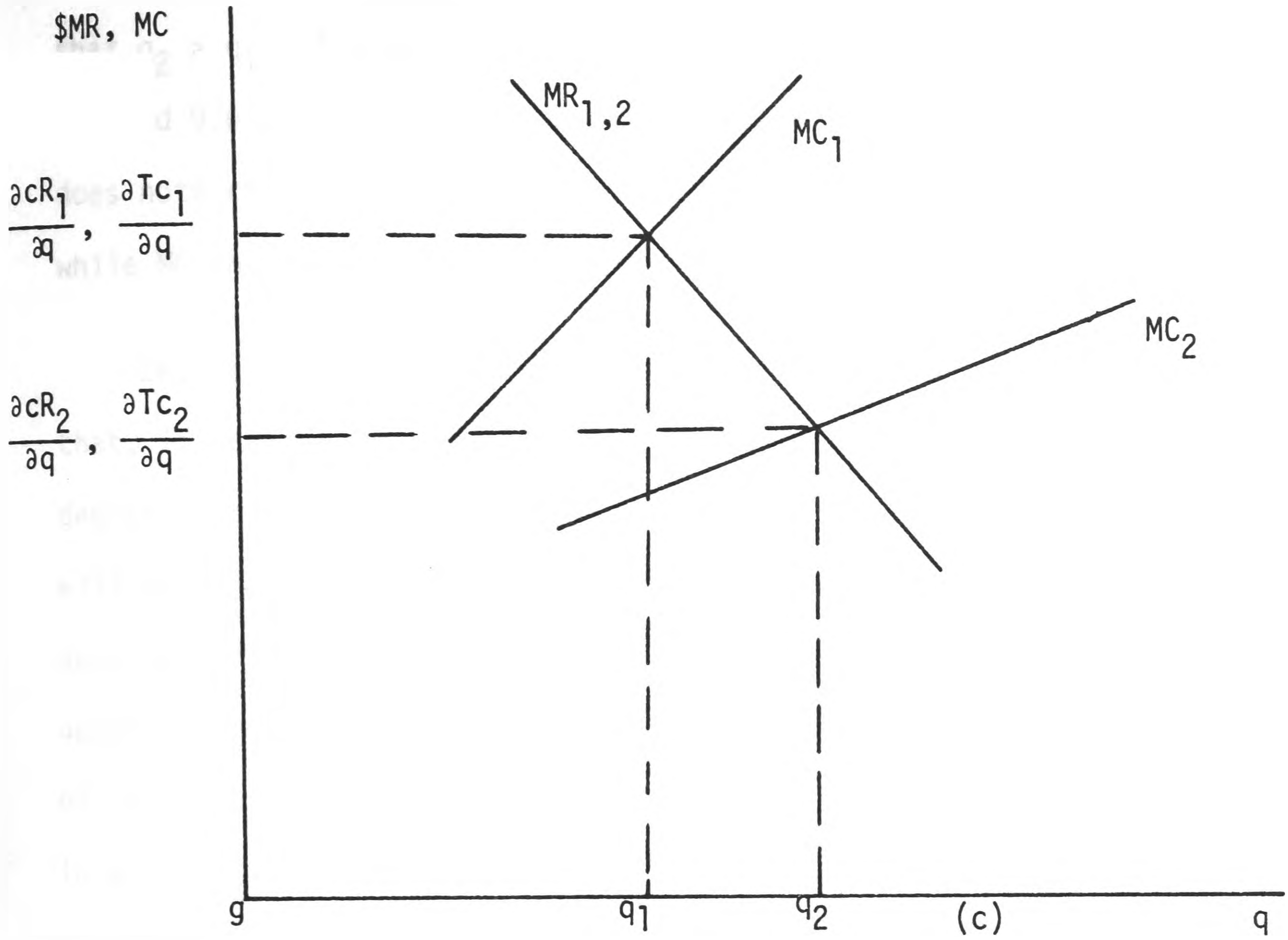


Figure 9.4



Suppose in Figure 9.4 that Sv_1 represents a maximum site value position given costs Tc_1 and revenue cR_1 i.e.

$$\frac{\partial cR_1}{\partial q} = \frac{\partial Tc_1}{\partial q} \qquad \text{at } q_1, Sv_1$$

As the size category increases to some size 2 marginal revenue will be greater than marginal cost at q_1,Sv_1 i.e.

$$\frac{\partial cR_2}{\partial q} > \frac{\partial Tc_2}{\partial q} \qquad \text{at } q_1, Sv_1$$

which necessarily implies a move to some point q_2,Sv_2 where marginal revenue and cost are again equated. Now, since $(cR_1 - Tc_1) > (cR_2 - Tc_2)$

and $\dfrac{\partial Tc_1}{\partial q} > \dfrac{\partial Tc_2}{\partial q}$

this implies that the point (q_2,Sv_2) will be lower and to the right of the point (q_1,Sv_1).

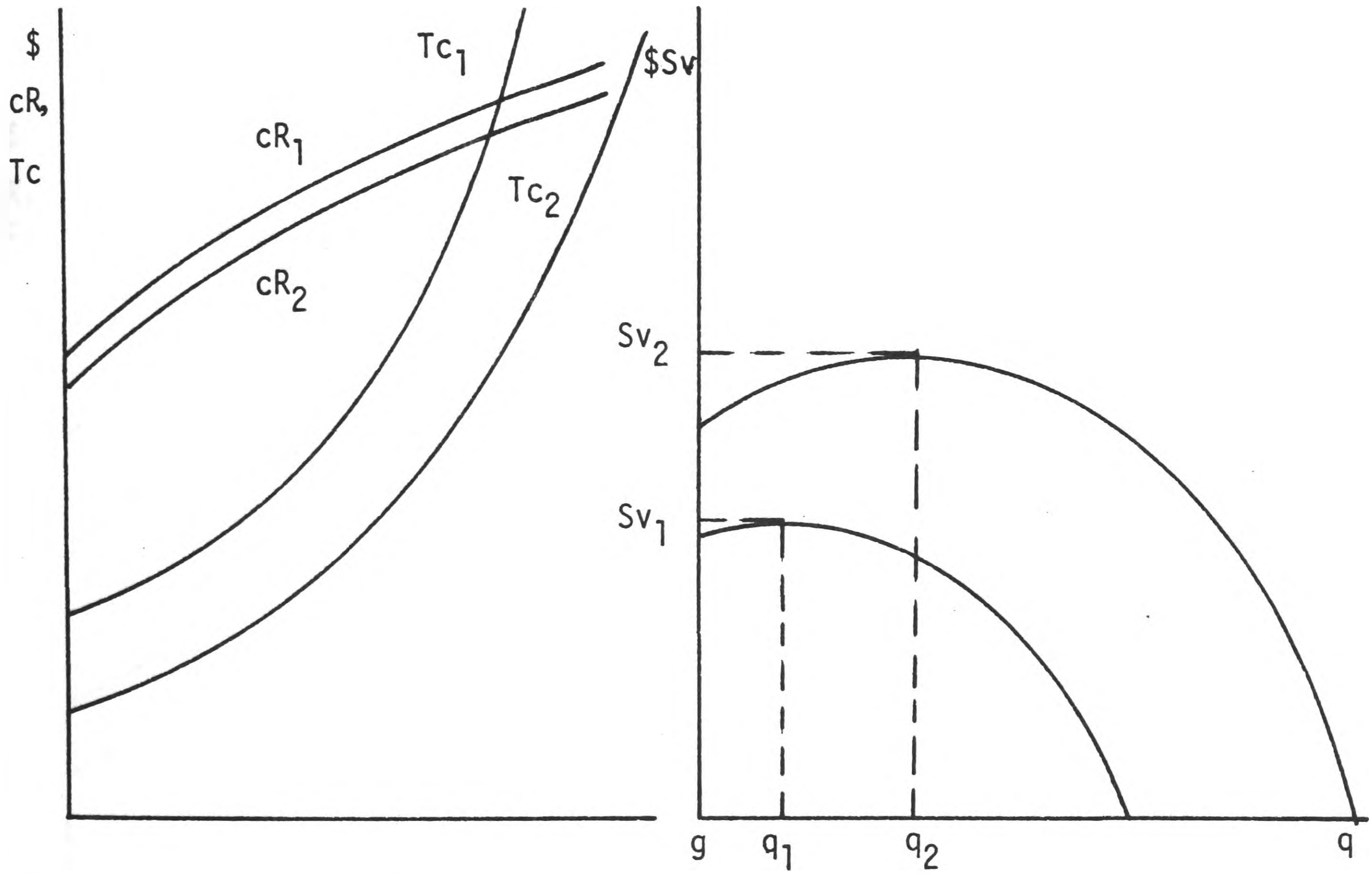
Diagrams (a) and (b) show that $Sv_1 > Sv_2$ while diagram (c) shows that $q_2 > q_1$. The marginal cost/marginal revenue diagrams for Figures 9.5 and 9.6 are similar to that for Figure 9.4. This is so since MR does note change with changes in size category (see Chapter six above) while MC changes in the same direction on each occasion.

Let us consider an implication of this result. In effect it means that, if tenants in the upper size categories have a relatively large degree of bargaining power then the central business district sky profile will be relatively low. Consider why this may be the case. Suppose the developer is faced with a decision of whether to supply space in the upper or the lower size categories under conditions of a high degree of tenant bargaining power in the upper size categories. It was shown in association with Figure 9.4 that, to supply floor space in the upper size categories (where tenants have the bargaining strength) the developer would have to build tall (i.e. achieve a more intense development of a given site than would be the case if he supplied space in the lower size categories - where landlords hold the balance of bargaining power) in order to attain profit maximising output. It was shown in association with Figure 9.4 that if the developer does supply space in the larger size categories (under the assumed conditions) he will be sacrificing some of the excess profits which he would be capable of obtaining if development takes place in the lower size categories (since $cR_1 - Tc_1 < cR_2 - Tc_2$). If we assume that the developer is a profit maximiser, then he will supply space in the lower size categories rather than the upper size categories - implying a relatively low sky profile.

On the other hand, if there is a greater relative movement in the cost curve as development takes place in larger size categories (which may occur, for example, if there is a lesser degree of tenant bargaining power in the upper size categories than that assumed above), then site value will increase. Such a case is shown in Figure 9.5. Here since $(cR_1 - Tc_1) < (cR_2 - Tc_2)$ and

$$\frac{\partial Tc_1}{\partial q} > \frac{\partial Tc_2}{\partial q}$$

Figure 9.5



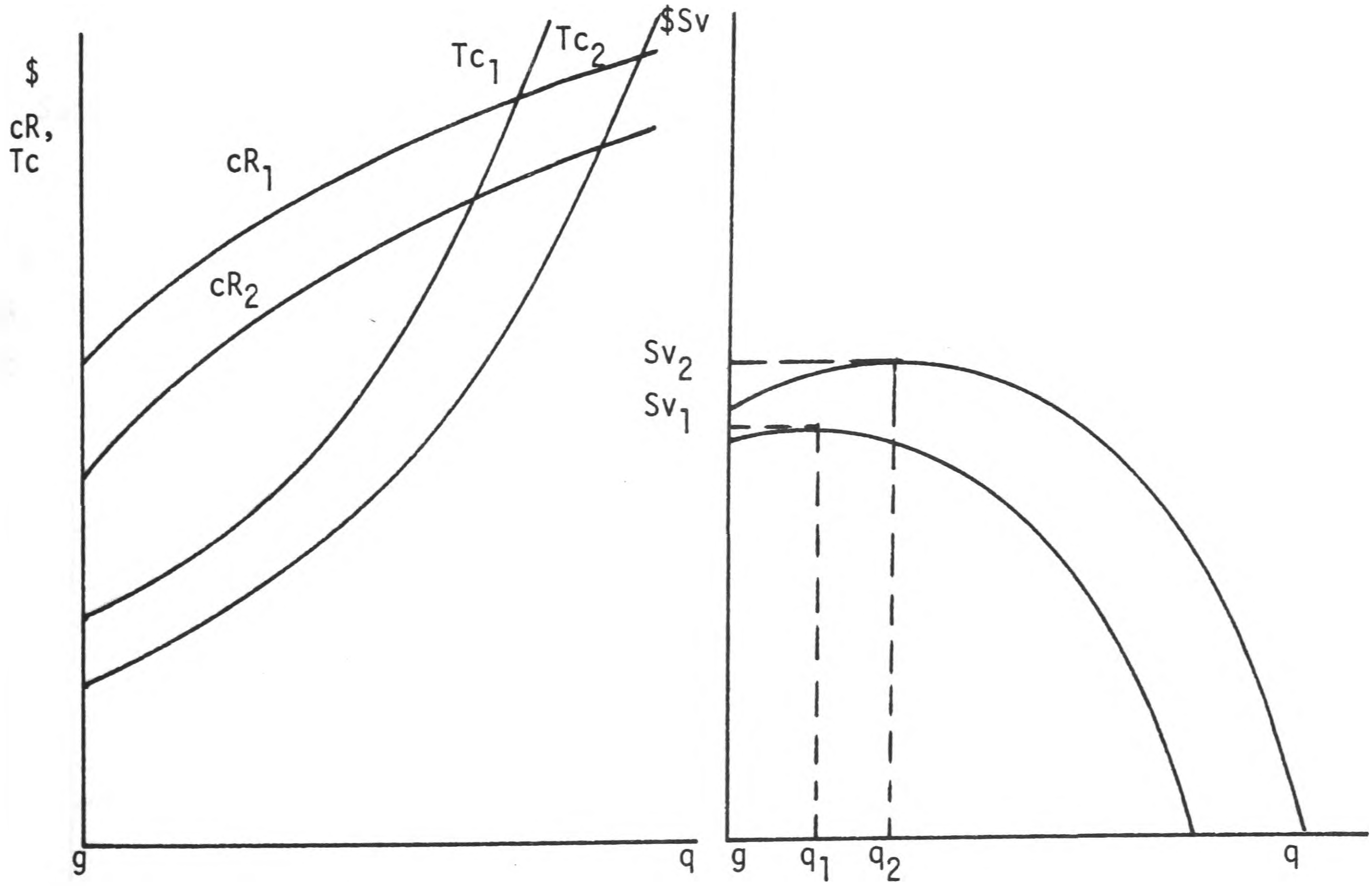
the point (q_2,Sv_2) will be higher and to the right (q_1,Sv_1). Under these conditions the central business district will have a relatively high sky profile.

There will also tend to be a relatively high sky profile in the central business district if USC landlords have relatively greater bargaining power than their LSC counterparts. This is shown in Figure 9.6. Here since $(cR_1 - Tc_1) < (cR_2 - Tc_2)$ and

$$\frac{\partial Tc_1}{\partial q} > \frac{\partial Tc_2}{\partial q}$$

the point (q_2, Sv_2) will be to the right and higher than the point (q_1, Sv_1). Thus as development takes place in higher size categories site value increases.

Figure 9.6



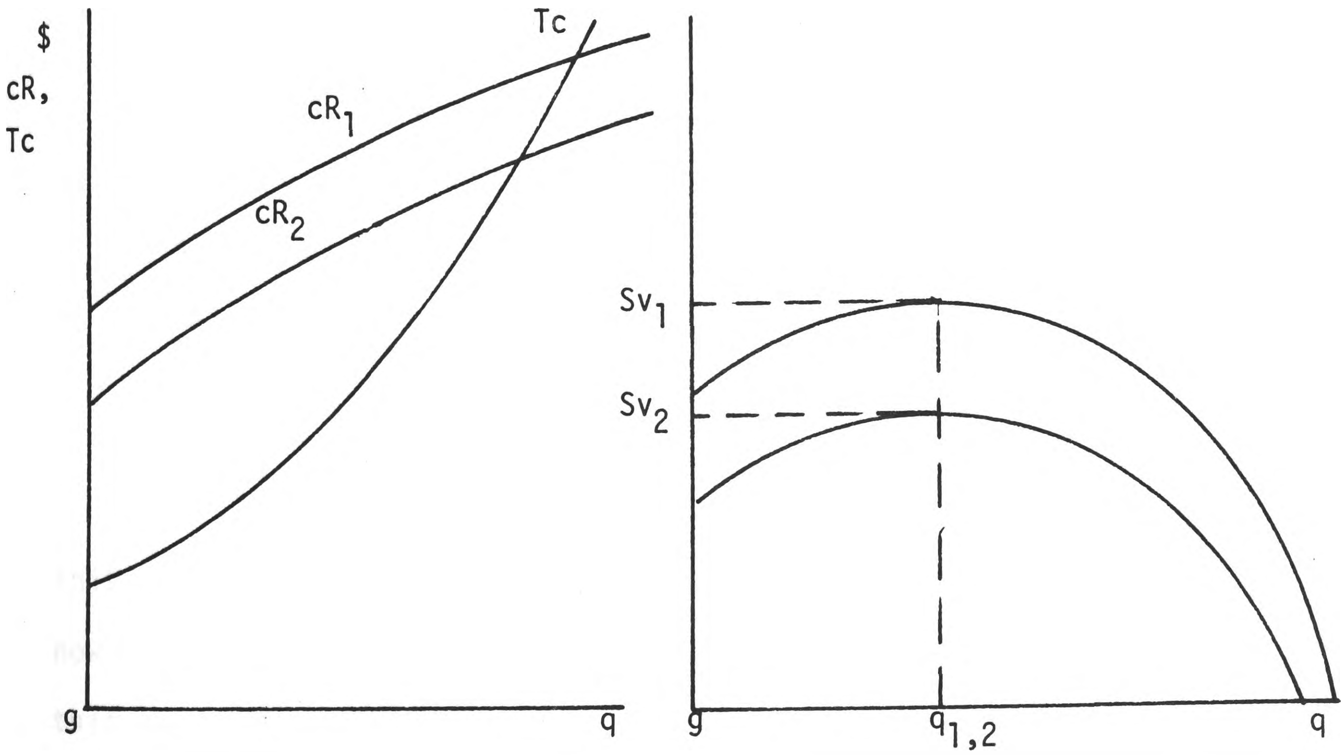
It should be noted that the particular sky profile (whether high or low) will continue only as long as the assumed conditions continue - and this will not be for an indefinite period. Rather what will tend to happen is that excess supply will emerge in size categories different to those in which it previously existed - changing the supply distribution,

the price structure (and consequently the demand distribution) and hence the relative bargaining power of landlord/tenant. From the new bargaining power structure may emerge a different sky profile. What the analysis is therefore suggesting is that, from each period of a given landlord/tenant bargaining power structure, will emerge a particular building height, or range of building heights (ceteris paribus) associated with a normal (i.e. profit maximising) intensity of development.[1]
In subsequent periods the bargaining power structure may again alter, thus altering the normal development intensity. Hence as time proceeds the central business district may take on a very varied sky profile.[2]

9.4 Vacancy Rates, Location and Site Value

Now, suppose there is a general increase in the vacancy rate. Such a case is shown in the following diagram:

Figure 9.7



1. To test the hypothesis being advanced here would require data over a very much longer period than that which was available for Wollongong.

2. This discussion presupposes that the developer will aim at a normal intensity of development rather than a maximum intensity of development. (By maximum here is meant the maximum site development allowed within the Town Plan Building Code). This assumption does not always hold.

Since $cR_1 > cR_2$ but Tc is unchanged this implies that $(cR_1 - Tc) > (cR_2 - Tc)$ so that $Sv_2 < Sv_1$. Also since

$$\frac{\partial cR_1}{\partial q} = \frac{\partial cR_2}{\partial q} = \frac{\partial Tc}{\partial q}$$

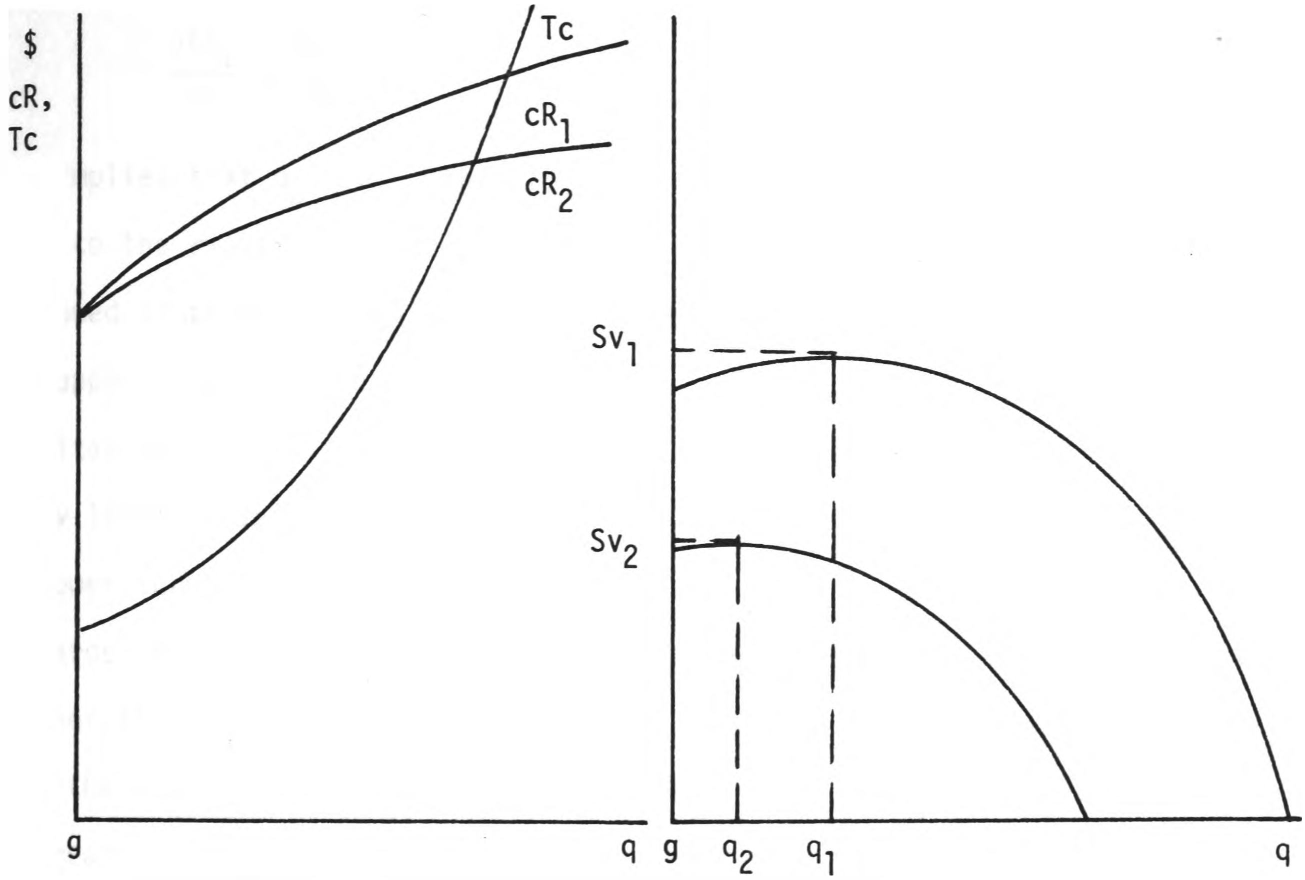
this implies that the point (q_1, Sv_2) will be directly beneath the point (q_1, Sv_1). Therefore under these conditions a general increase in the vacancy rate will reduce land values but will leave the normal level of development unchanged. The site value decrease may be revealed in either a decrease in the land cost element of redevelopment, or a decrease in excess profits, or both. (An increase in the general vacancy rate may occur in a situation where the existence of supernormal profits has encouraged a large number of firms to enter the redevelopment industry. The resulting excess supply tends to reduce rents and one of the consequences may be a departure of some firms from the industry. This is discussed more fully in Chapter eleven below).

A completely expected result ensues when the vacancy rate on the upper floors increases relative to that on the lower floors (shown in Figure 9.8). Here $(cR_1 - Tc) > (cR_2 - Tc)$ therefore $Sv_2 < Sv_1$. However since

$$\frac{\partial R_2}{\partial q} < \frac{\partial R_1}{\partial q}$$

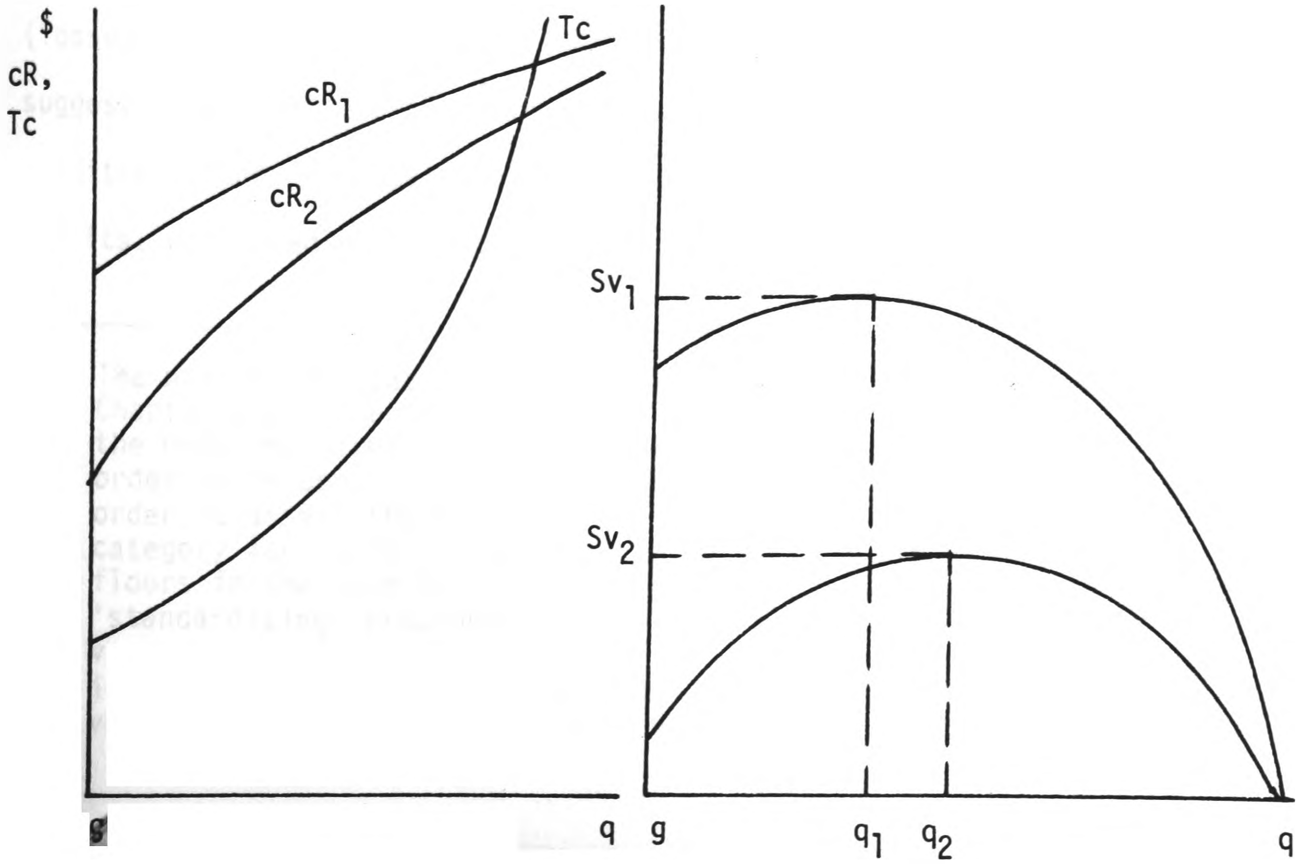
this implies that MR < MC at the point (q_1, Sv_2) and equilibrium will now be attained at some value of q which is less than q_1. Therefore this new equilibrium point (q_2, Sv_2) will be lower and to the left of (q_1, Sv_1). Thus if there is a relatively greater decline in the occupancy rate on the upper floors the site value will decline and the normal level of capital/land substitution will decrease.

Figure 9.8



On the other hand, if the vacancy rate on the lower floors increases relative to that on the upper floors a very interesting result, in terms of the present model, follows. This is shown in the following diagram:

Figure 9.9



Here since $(cR_2 - Tc) < (cR_1 - Tc)$ it implies that $Sv_2 < Sv_1$ and since

$$\frac{\partial cR_2}{\partial q} > \frac{\partial cR_1}{\partial q}$$

it implies that $q_2 > q_1$. Therefore the point (q_2, Sv_2) will be lower and to the right of the point (q_1, Sv_1). That is, although land value is reduced if there is a relatively greater increase in lower floor than in upper floor vacancies, equilibrium is at a much higher level of capital/land substitution. Under these conditions it is likely that very little development will take place since the entrepreneur will have a lower turnover of his capital due to the longer gestation period with a larger project, while there is a smaller incentive to develop. This rather strange result is worth considering a little further. The only way the supply of floor space on the upper floors can be increased is by increasing the supply of lower floor space. However, this aggravates the excess supply condition existing on the lower floors, depressing profits and land values even further. Should this type of situation develop (i.e. excess supply on the lower floors) then very little development in the aggregate will take place due to reduced profit (losses may, in fact, develop) incentives. The model itself simply suggests that, if development should take place under the hypothesised conditions, then that particular developer, if he wishes to maximise profits, will need to utilise the site more intensively.[1]

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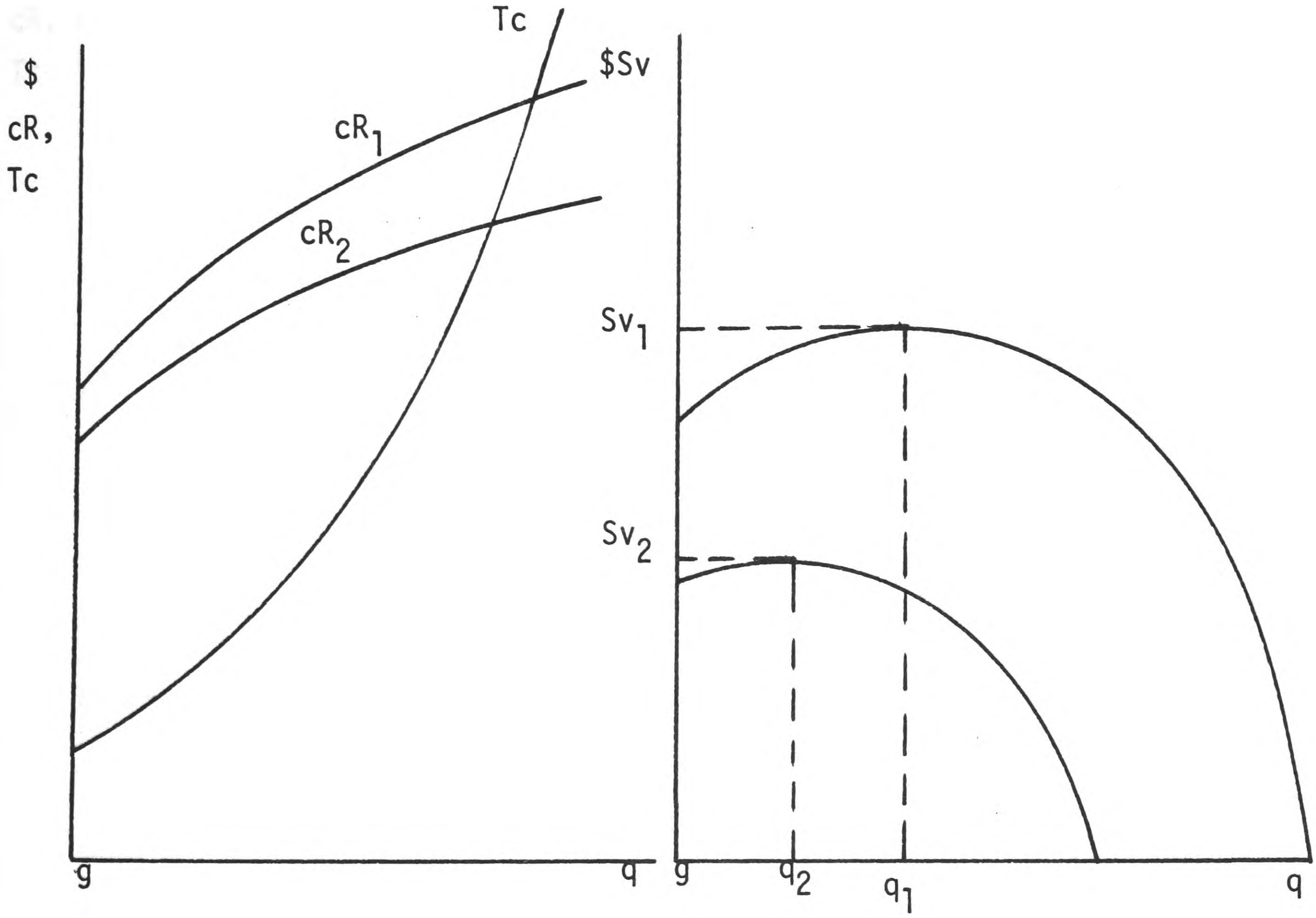
1. The notion of relative and absolute vacancies was disucssed in Chapter six above (see p. 175fn. 2). There it was suggested that the model required rélative vacancies (for comparative purposes) in order to be operable. That is, vacancies had to be 'standardised' in order to assess the relative 'strength' of upper and lower size category landlords. However, with respect to compariso ns between floors in the same building (assuming size category is constant) such as 'standardising' procedure is not required. That is, absolute vacancies may be utilised here if desired. However, for consistency it is perhaps better to pursue the analysis utilising relative vacancies since the results will not be affected.

Using this model, other things being equal, it may be seen that site value will decrease as distance from the PLV site increases. This is shown in Figure 9.10 (where Tc reflects development costs exclusive of site acquisition costs). Here since $(cR_1 - Tc) > (cR_2 - Tc)$ and

$$\frac{\partial cR_1}{\partial q} > \frac{\partial cR_2}{\partial q}$$

Figure 9.10

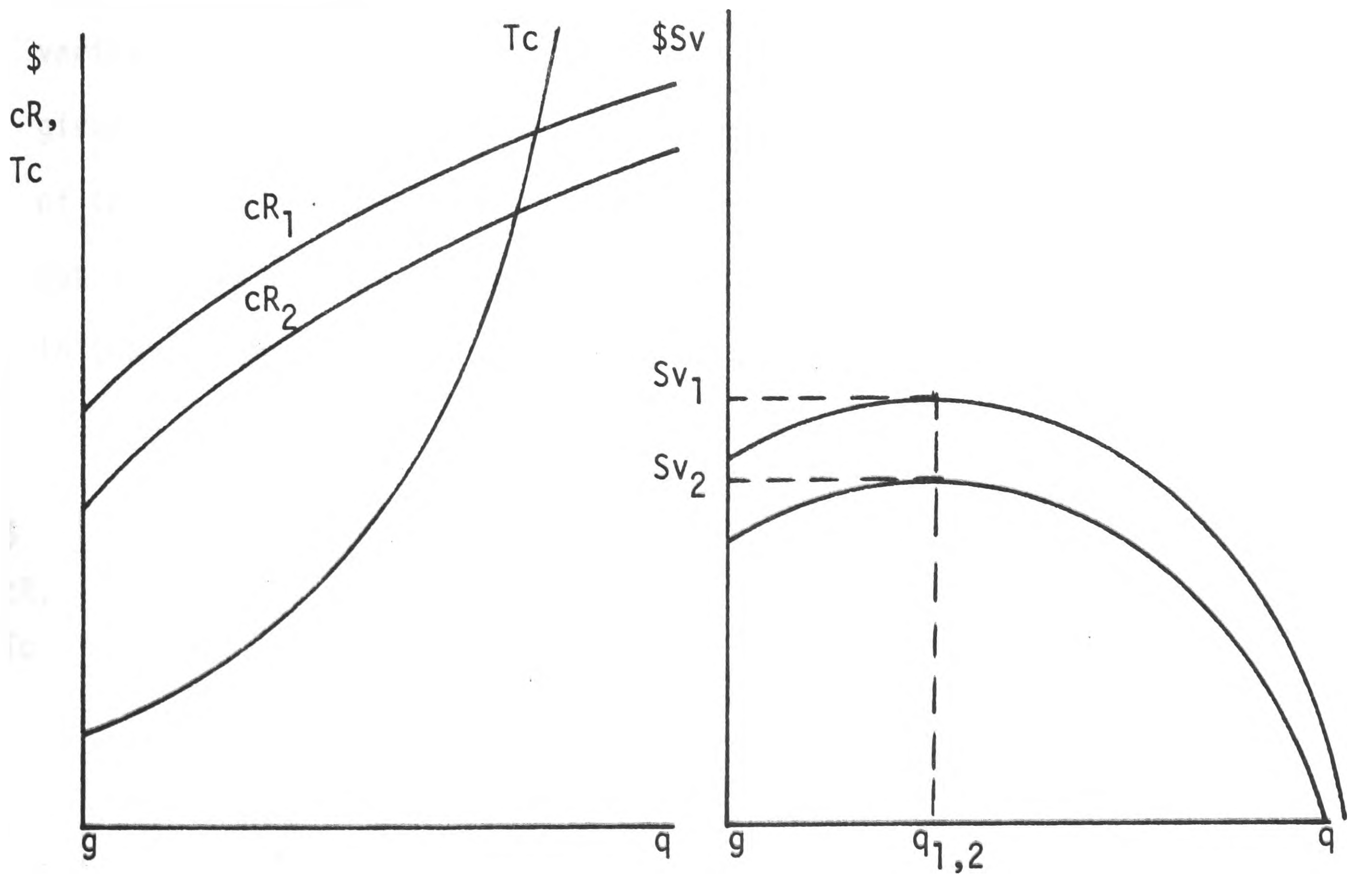


then the point (q_2, Sv_2) lies below and to the left of the point (q_1, Sv_1). Thus site values will decrease, and there will be a falling sky profile as distance from the centre increases, which is consistent with conventional land value theory.

If the capitalisation rate increases there will be a decrease in maximum site value. This is shown in Figure 9.11. Here since $(cR_1 - Tc) > (cR_2 - Tc)$ this implies $Sv_1 > Sv_2$ and since

$$\frac{\partial cR_1}{\partial q} = \frac{\partial cR_2}{\partial q}$$

Figure 9.11

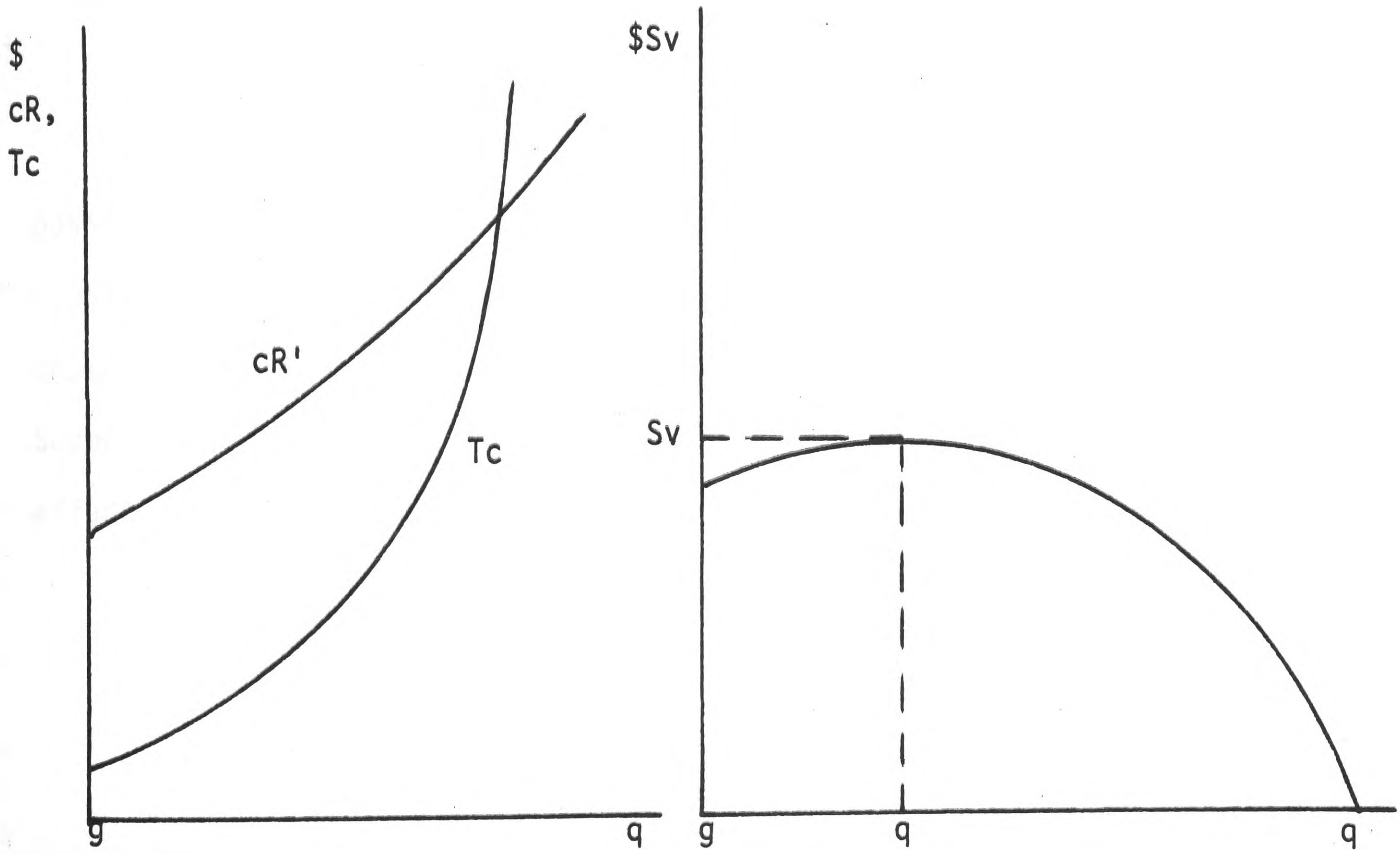


this implies q is unchanged. Therefore the point (q_1, Sv_2) will be immediately beneath the point (q_1, Sv_1). Thus site value will decrease but the normal intensity of site utilisation will remain unchanged.

9.5 The Alternative Proposition on Rent Variation and its Effect on Site Value.

Consider the alternative proposition that per unit rents increase with height above ground floor level. In this case how will site values vary as bargaining power, vacancy rates and location vary? First consider the variation in site value as output (floor space production) varies on a given site. If it is assumed that initially (up to some given height) the slope of the revenue function is greater than that of the cost function then it may be shown that site value varies with output in much the same manner as previously. This is shown diagrammatically in the following figure:

Figure 9.12



In Figure 9.12

$$cR' = \frac{\beta'\theta q}{ic(q + \theta\alpha')} + \frac{\lambda' q}{ic} \qquad 9.6$$

and maintaining the condition that

$$\frac{\partial r'}{\partial h} > 0$$

Tc remains defined as before.

Initially

$$\frac{\partial cR'}{\partial q} > \frac{\partial Tc}{\partial q}$$

but after some point q, since

$$\frac{\partial cR'}{\partial q} \text{ approaches } \lambda$$

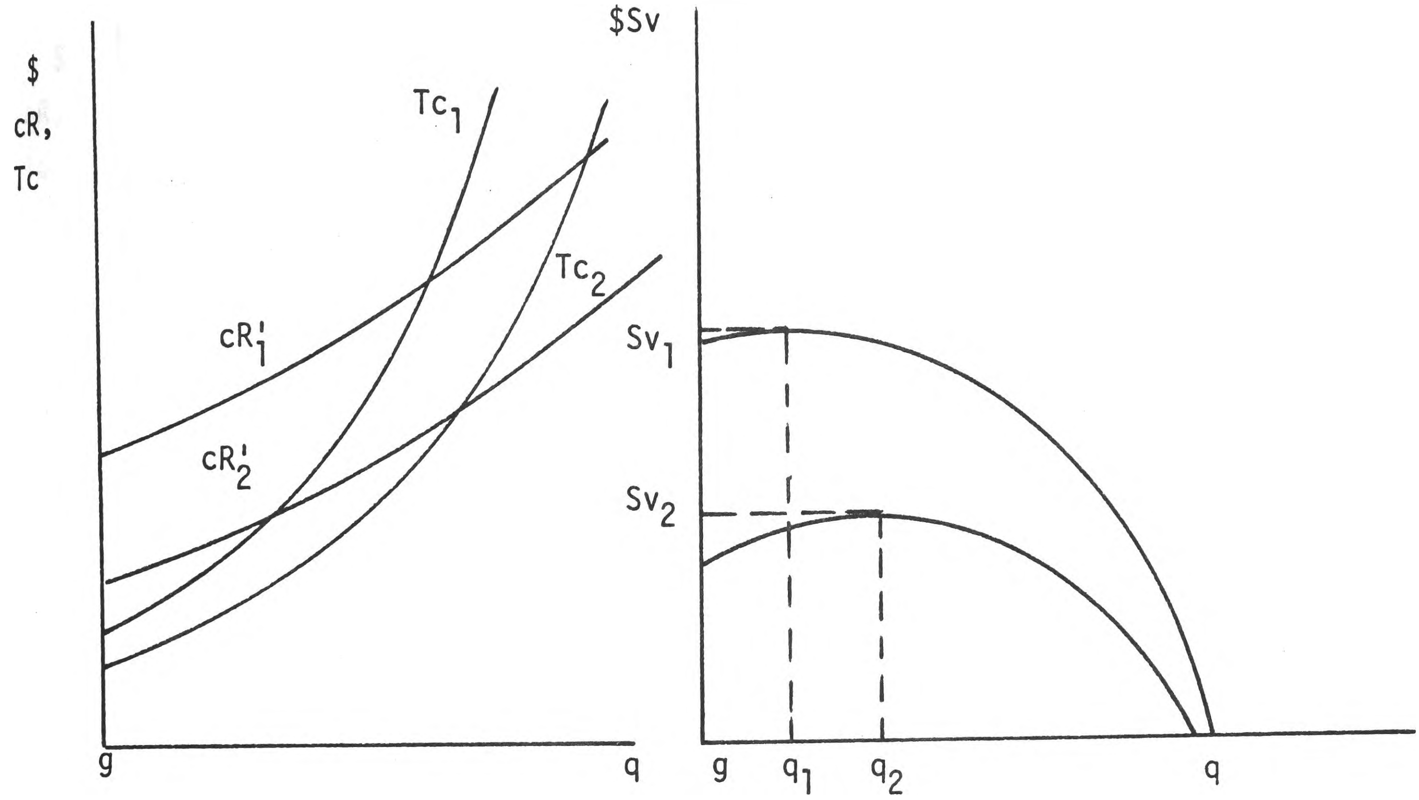
$$\frac{\partial Tc}{\partial q} \text{ will be greater than } \frac{\partial cR'}{\partial q}$$

Once again maximum site value is at some point (q,Sv) where

$$\frac{\partial cR'}{\partial q} = \frac{\partial Tc}{\partial q}$$

Now, if the LSC landlords are in a relatively better bargaining position than USC landlords the effect on site value of a developer supplying floor space in the larger size categories will once again depend on the relative movement of the cost and revenue curves. Suppose the relative movement is greater in the revenue curve. The effect is shown in the following diagram:

Figure 9.13



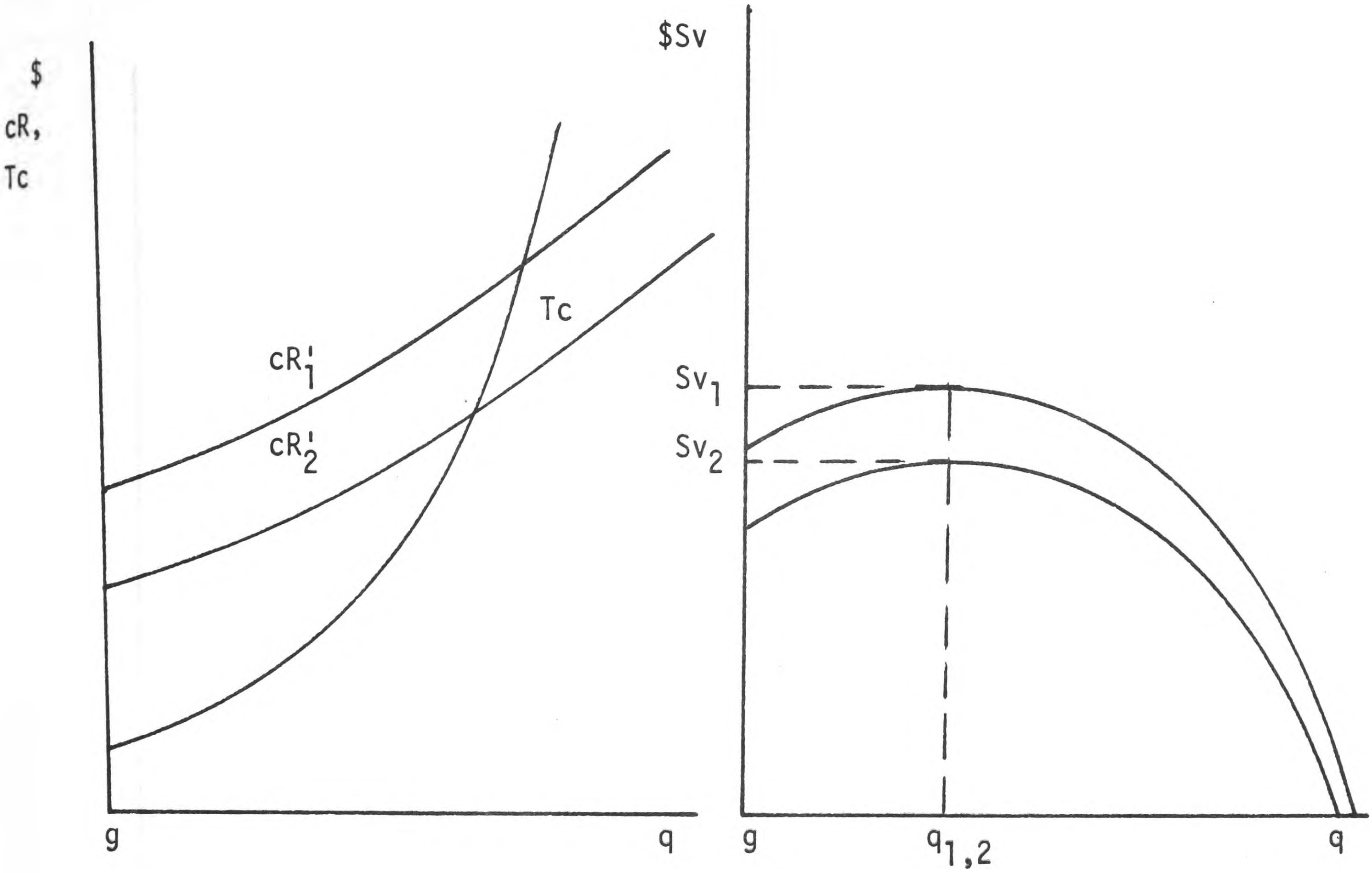
Here $(cR_1' - Tc_1) > (cR_2' - Tc_2)$ therefore $Sv_1 > Sv_2$. Furthermore

$$\frac{\partial cR_1'}{\partial q} > \frac{\partial Tc_2}{\partial q} \qquad \text{at } q_1$$

which implies a move to some q which is greater than q_1. Therefore the point (q_2, Sv_2) will be lower and to the right of (q_1, Sv_1). This result is precisely that established for the case where per unit rents decrease as height above ground floor increases. In a similar manner it may be demonstrated that the remaining results relating to bargaining power and vacancy rates also hold in the current situation.

In what manner will site value and development intensity vary as distance from the PLV site increases? If it is assumed that there is no alteration in relative locational desire between lower and upper floors then site values will decrease but the sky profile will remain unchanged as distance from the PLV increases. This is shown in the following diagram:

Figure 9.14



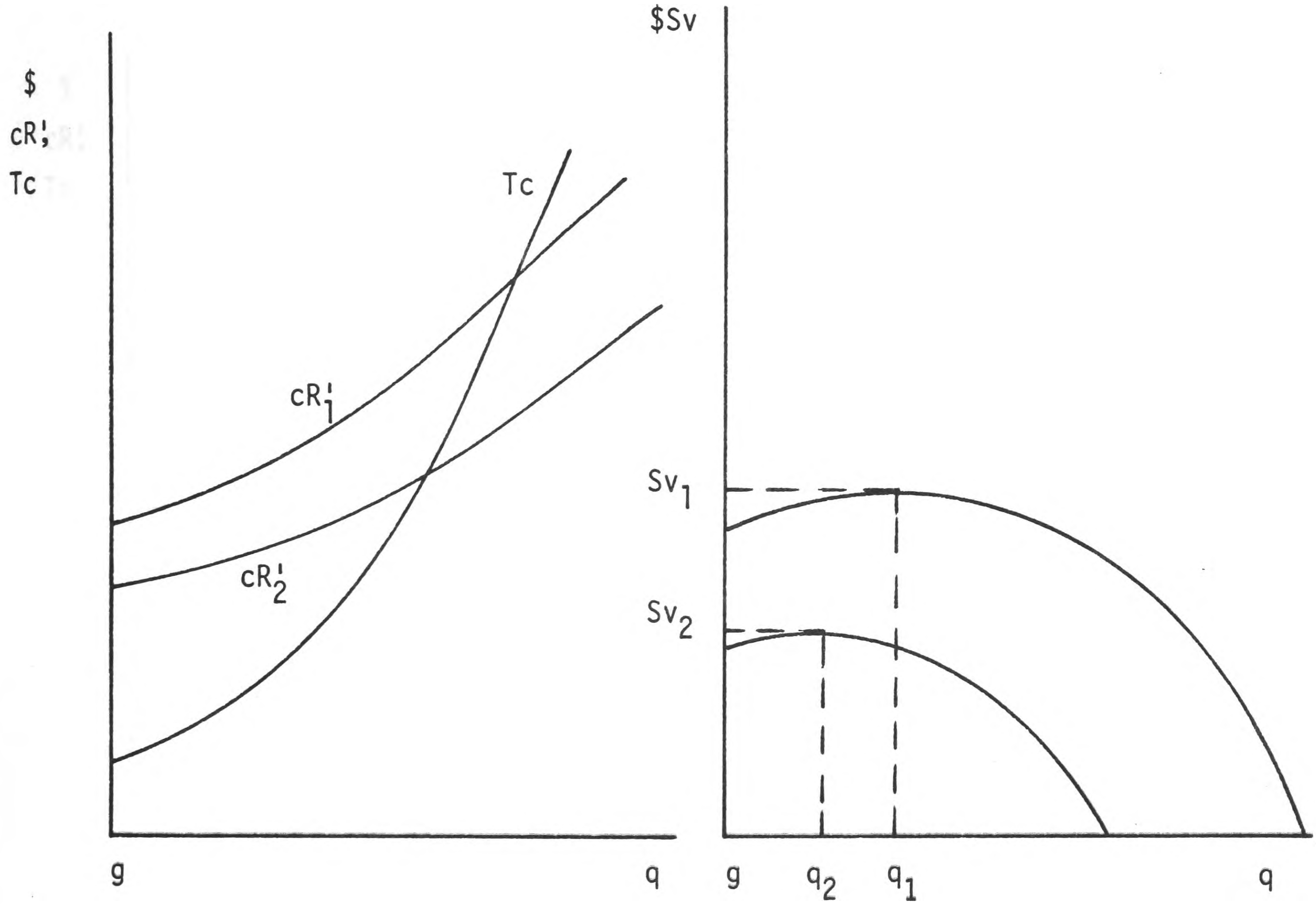
Here since (cR' - Tc) < (cR' - Tc)

$$\text{and} \quad \frac{\partial cR_1'}{\partial q} = \frac{\partial cR_2'}{\partial q}$$

the point (q_2, Sv_1) is immediately beneath (q_1, Sv_1). However, since it is unlikely that any city profile will conform to this prediction it appears that the assumption of no alteration in relative locational desires between ground and upper floors is untenable.

Suppose there is a decrease in the relative desire for upper floor location as distance from the PLV site increases. This case is shown in the following diagram:

Figure 9.15



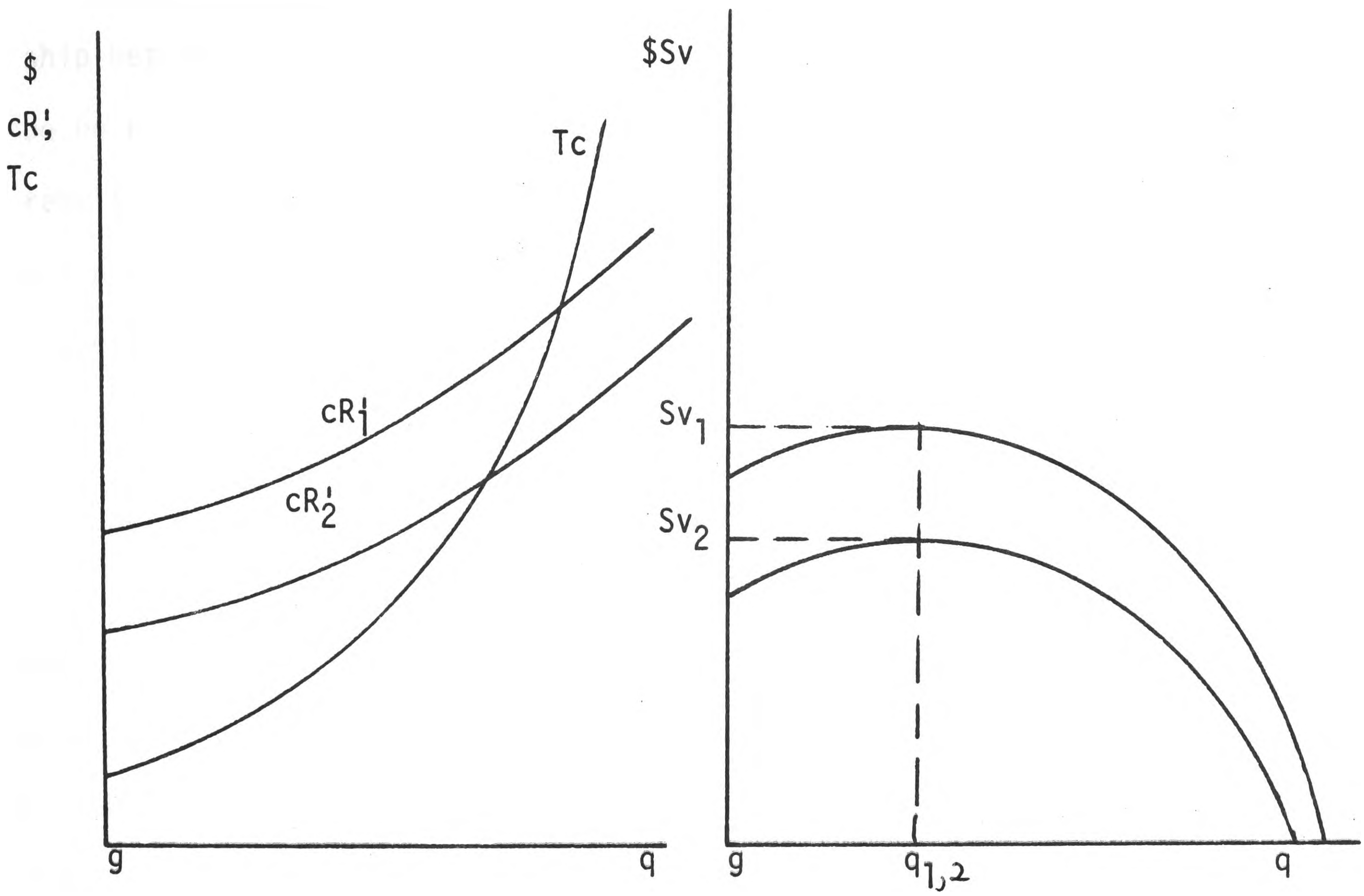
Here since $(cR_2' - Tc) < (cR_1' - Tc)$

and $\dfrac{\partial cR_2'}{\partial q} < \dfrac{\partial cR_1'}{\partial q}$

the point (q_2, Sv_2) is below and to the left of the point (q_1, Sv_1). Thus in this situation land values and the sky profile will fall as distance from the PLV site increases.

An increase in the capitalisation rate will decrease site value but will leave the optimum output (floor space production) level unchanged. This is shown in the following diagram:

Figure 9.16



In Figure 9.16 since $(cR_2 - Tc) < (cR_1 - Tc)$ this implies $Sv_2 < Sv_1$ and since

$$\frac{\partial cR'_1}{\partial q} = \frac{\partial cR'_2}{\partial q} = \ldots \frac{\partial cR'}{\partial q}$$

this implies that q is unchanged. Therefore the point (q_1, Sv_1) will be directly above the point (q_2, Sv_2).

9.6 Site value and the Variation in Size of Site.

In Chapter three it was shown that, for Wollongong, the relationship between value and the size of site may be negative, or there may be no relationship, or there may be a positive relationship. This result, it was pointed out, tended not to agree with established theory. Let us now consider whether these relationships are possible within the framework of the present model.

Perhaps the most practicable approach to the discussion is to consider a variety of situations. Let us continue to assume complete site cover (so that any parking requirements are met under shelter),[1] and a lower modal distribution. Now, if there is complete site cover then, as a general rule, the larger the lot size the greater will be the cost of supplying floor space in the smaller size categories.[2] That is, the larger the lot size the greater will be the number of subdivisions required to produce floor space in a given size category, and thus the greater will be the upward pivot of the cost curve as space is supplied in the smaller size categories.

Now, suppose the site area - as reflected in the floor space constant, θ - is greater than that size category which produces the maximum rent. Suppose, however, that θ is less than 100 percent greater than the size category which produces the maximum rent. Now, any subdivision of θ can produce, at most, 1 maximum rent producing category, and with an equal subdivision no maximum rent producing categories will

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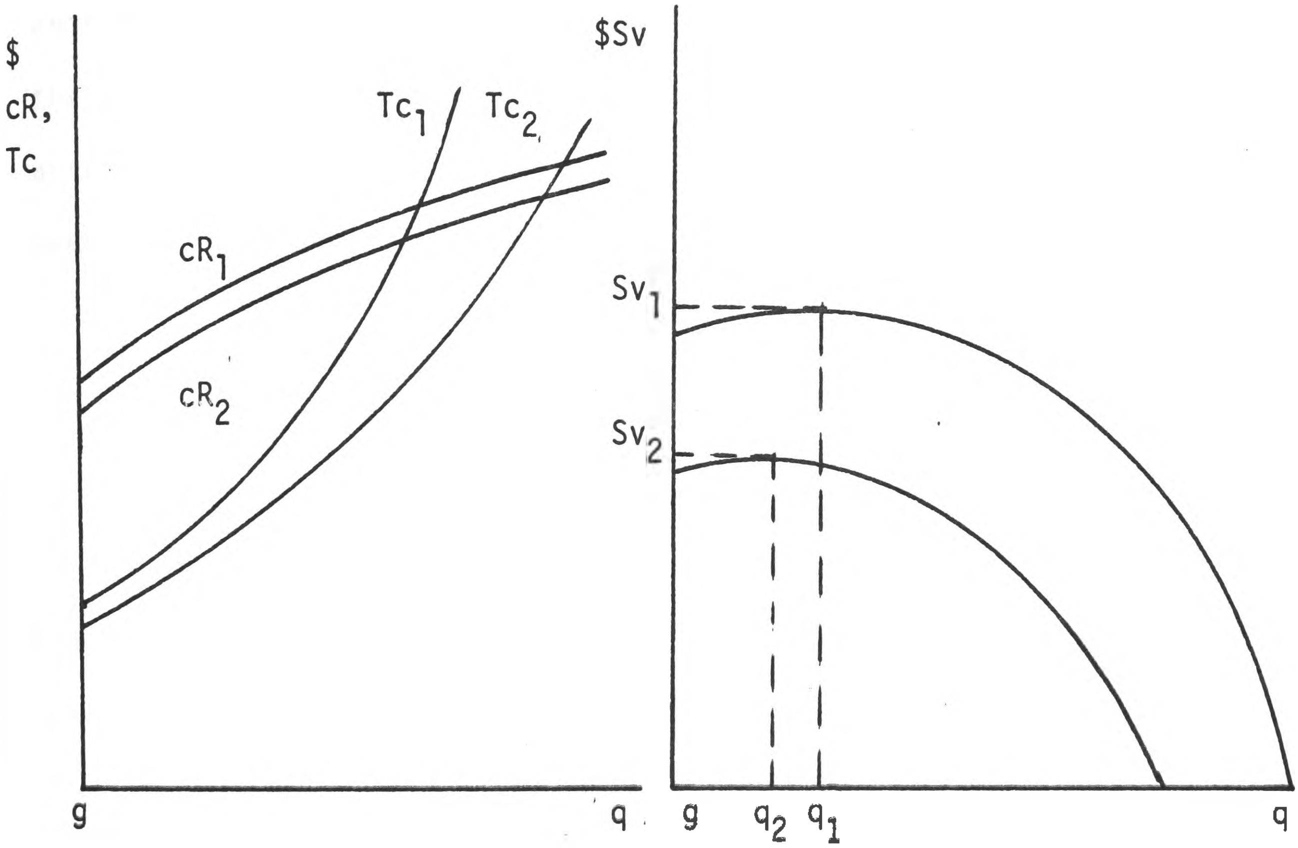
1. For large developments, if allowable, this may be the most rational long term decision.

2. See Chapter eight above.

emerge. In this situation, if the relative movement in the cost curve is greater than the relative movement in the revenue curve the site value will decrease. This is shown in the following diagram:

Figure 9.17



Here since $(cR_1 - Tc_1) > (cR_2 - Tc_2)$

$$\text{and} \quad \frac{\partial cR_2}{.\partial q} < \frac{\partial cR_2}{\partial q} \qquad \text{at } (q_1, Sv_1)$$

this implies that, if floor space is to be produced in the smaller size categories on this lot, then any development will take place at some point (q_2, Sv_2)[1] which is below and to the left of (q_1, Sv_1). Obviously then, in this situation there is no incentive to produce floor space in the smaller size categories.

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1. As suggested earlier in the chapter, the intensity of development does not refer strictly to the quantity of floor space, but to the floor space in relation to the site area. Thus, for example, a small site area may have a greater intensity of development than a larger one, but may still have a smaller absolute quantity of floor space.

Compare the site area (0) which, if developed just caters for the maximum rent producing size category, with the larger site area (L) discussed above. On 0 the per unit construction costs may be greater than on L.[1] On 0, however, the revenue function (expressed on a per unit basis) will be higher than on L. If $(cR_0 - Tc_0) > (cR_L - Tc_L)$ the per unit site value associated with site 0 will be greater than that associated with site L. Hence, in this situation, there will be a negative relationship between per unit site value and size of site.

Now, suppose that two relatively small adjacent lots differ in size by 100 percent. On the smaller lot the site area is equivalent to the floor space size category obtaining the maximum per unit rent. On the other lot, in order to obtain the maximum per unit rent, all that is required is one subdivision. If, with this subdivision, the upward movement in the cost curve is such that the per unit cost on each site is equated, then the per unit value of the two sites will be equated (since, by definition, the per unit revenue curves will be equated), even although the sites differ in size by 100 percent.[2] This is shown in Figure 9.18. Here $(cR_1 - Tc_1) = (cR_2 - Tc_2)$

$$\text{but} \quad \frac{\partial cR_2}{\partial q} < \frac{\partial cR_2}{\partial q} \qquad \text{at } q_1$$

so that development on the larger block takes place at a lesser intensity if floor space is supplied in the smaller size categories. However the per unit site value does not vary with the size of the site.

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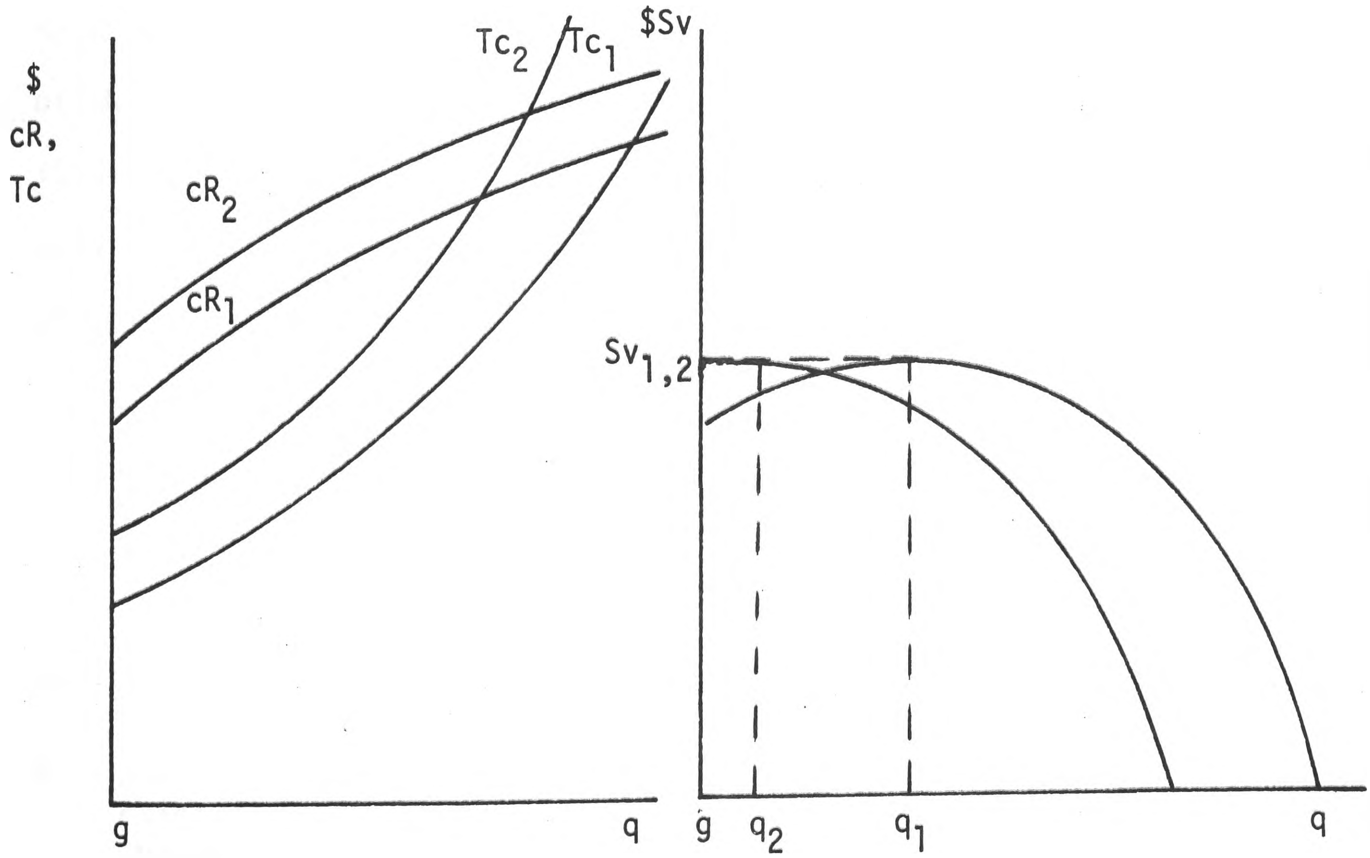
1. See Chapter eight above.

2. The difference of 100 percent was only chosen by way of example.

As a final example suppose, once again, that two adjacent lots differ in size by 100 percent. Suppose the maximum rent producing floor space size category requires an increase of 100 percent in the size category obtainable on the smaller lot (that is, in this situation it is not possible to have the maximum rent producing size category on the smaller lot). Since the larger site permits development so as to maximise per unit rents (and since per unit costs may be lower) the larger site will possess the larger per unit value. That is, in this situation there will be a positive relationship between value and size of site.

Figure 9.18



Therefore, using the model developed in the previous chapters, it may be observed that it is possible to have a positive, negative or no relationship between per unit value and size of site. As implied in the above examples, given information on such variables as revenue, costs, and the relative distributions of the supply of, and demand for, floor space it is possible to specify the relationship between value and size of site.[1]

9.7 Conclusion

The analysis in this chapter has shown that the intensity of utilisation and the site value will depend on the shape and height of the revenue and cost curves. This discussion is carried further in the next chapter. There the model is utilised in considering the problem of whether land value determines intensity of utilisation, or whether it is the other way round. The problem is shown to be one of a 'micro' vs a 'macro' approach. In the meantime let us list some of the conclusions of the present chapter:

(i) The normal (profit maximising) intensity of site utilisation will occur when marginal revenue and cost are equated. If this condition does not hold the site will either be under-or over-developed.

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1. Note that the data on land values was obtained from properties with existing buildings. The determination of actual site value would therefore, have depended on the existing rentals. That is, site value determination would have been based on the assumption that the same rental (appropriately adjusted for depreciation and obsolescence - discussed in Chapter eleven) would be obtained with a new building. However, the developer may decide to supply floor space in different size categories to those currently existing so that the site value after redevelopment may differ from that immediately before re-development if such a decision is taken (other reasons why value may differ are discussed in Chapter eleven). Clearly, the particular market situation, as well as the location and topographical factors, needs to be taken into consideration.

(ii) If the upper size category tenants have a relatively high degree of bargaining power the CBD sky profile will be relatively low, and vice versa. Since the bargaining power structure may be expected to change through time so, also, will the normal (profit maximising) sky profile. Therefore at any given moment of time the CBD sky profile may be expected to be highly varied reflecting, inter alia, different barganing power 'periods'.

(iii) An equal variation in vacancy rates throughout all size categories will leave the normal intensity of site utilisation unchanged but will cause land values to vary.

(iv) Variations in vacancy rates between upper and lower floors will alter both site values and normal intensity of utilisation.

(v) Within the structure of the model, ceteris paribus, there will tend to be a falling sky profile towards the periphery of the CBD.

(vi) Variations in the capitalisation rate will cause both site values and normal development intensity to vary.

(vii) Variation in value as size of site varies depends on the landlord/ tenant bargaining power structure.

CHAPTER 10

CAPITAL/LAND SUBSTITUTION

10.1 Introductory Statement

This chapter completes the analysis of Part III. The discussion in section 10.2 concerns an apparent controversy on whether land value is determined or determining with respect to intensity of utilisation. It is suggested that the controversy may, in effect, be due to a 'micro' and a 'macro' view of the problem. From the standpoint of the individual firm, concerned with the problem of building expansion to house a growing business, it may appear that land value determines intensity of site utilisation i.e. capital/land substitution. However it was suggested in previous chapters that the market at large (the market for floor space in the CBD and costs in the building industry generally) will suggest an 'appropriate' (i.e. normal) intensity of utilisation and from this will emerge a maximum land value. Section 10.2 considers the manner in which these two notions may be reconciled. There is a feedback involved between these 'macro' and 'micro' views in the sense that an alteration in site value as determined by some variation in the normal capital/land substitution ratio will affect the building decision of the individual which, in the aggregate, will affect the normal capital/land substitution. One aspect of this feedback system is considered in section 10.3 viz. the manner in which a variation in capital/land substitution will affect land value (and, by implication, the location and construction decision of the individual firm).

10.2 The Problem of Land Values and Intensity of Utilisation

It is an elementary economic proposition that if, for a particular production function, there are two (incomplete) substitutable factor inputs and one output, and if the marginal product of each factor is positive, and if the firm is operating under diminishing marginal returns, then the isoquants will be convex to the origin. Furthermore, given independent costs for each input factor it is possible to ascertain an efficient combination of input factors in the production of a given output. Such a combination is obtained at the point of tangency between the isocost and isoquant curves. A change in relative prices will lead to a movement along the isoquant to a new tangency position. That is, there will be a substitution of the relatively less expensive for the relatively more expensive factor.

Although this may be an elementary economic proposition some care needs to be taken in the interpretation of its application. Consider two factor inputs in the production of floor space viz. land and capital (assume that these arethe only factor inputs). Application of the above mentioned proposition in the property sphere would appear to suggest that as land becomes more expensive relative to capital then (in the production of some given quantity of floor space) capital would be substituted for land and consequently land would be utilised more intensively. This notion is well supported in the literature. For instance, Marshall argued that "If land is cheap he (the businessman) will take much of it; if it is dear he will take less and build high".[1] Marshall continued that the quantity of capital to be applied to a given site will be governed by the saving in the cost of land obtained by adding an extra floor (the 'margin of building').[2] In a similar vein

1. Guillebaud, op.cit., p. 448.

2. Ibid.

Bourne has stated "The effect of a rise in the cost of land on an investment in redevelopment will be to encourage the developer to substitute capital for land and thus to increase the intensity of use".[1] Therefore, along the above lines, it may be argued that land value determines the intensity of site utilisation.

In apparent contradiction to this notion Turvey has argued that land values are a consequence not a cause of intensity of utilisation "But apart from this minor and indirect effect via the marginal cost of funds, the price at which the site can be obtained has no effect upon the sort of building which it is most profitable to erect given unchanged average and marginal net returns upon construction outlay. It is therefore misleading to speak of land values as determining the kind of buildings put up; the causation is the other way round".[2] In earlier chapters of the present work it was argued that site value depends on the intensity of utilisation which, in turn, depends on the shape of the revenue and cost curves. That is, in a similar vein to Turvey it was argued that land values are a consequence not a cause of intensity of utilisation.

It would appear that at this point something of an impasse has been reached. However it may be possible to reconcile these apparently conflicting viewpoints. As is often the case for explanatory purposes, it may be easier to consider an extreme example. Let us pose the question - which was established first, urban land values or the urban base (land uses housing the various economic activities which compose a city)? At the extreme this is not the 'chicken and egg' problem

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1. Bourne, L. S. Private Redevelopment of the Central City, The University of Chicago Press, 1967, p. 28.

2. Turvey, op.cit., p. 17.

that it appears to become with later urban development. The answer to our question is quite straightforward. The demand for land is derived from the use to which that land may be put. As the demand for floor space of a particular type in a given place increases so will the intensity of site utilisation and consequently site values.[1] In essence this represents a macro (city wide) view of the problem.

Consider again the analysis of previous chapters. This too represents a macro view, but not in the sense that it deals with aggregate land values. Rather, this analysis deals with the aggregate supply and demand forces which determine the shape and position of the revenue curves for similar properties. Essentially we are dealing with abstract phenomena. In effect it is being suggested that, given the current supply and demand conditions, a structure of this type and size will maximise the positive difference between costs and revenue and hence will produce the maximum current value for the given site. Again the direction of causality is clear. Land values are a consequence of the intensity of utilisation.

Let us consider briefly the manner in which an individual firm may view a problem of building expansion. As indicated above Marshall has argued quite rationally that a businessman will trade-off the costs associated with vertical and horizontal expansion. In that case from the point of view of the individual firm (i.e. a micro view) it may appear that land value determines the intensity of site utilisation. Consider a hypothetical case which may help to show this. Suppose a owner occupier carries on his business in a one storey building

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1. Cf. the discussion in Chapter nine above.

which completely occupies a site. Adjacent to this are two similar sized, vacant sites. The relative distributions of the supply and demand for floor space[1] indicate that the normal intensity of site utilisation[2] with the current use (which also happens to be the best use of the site) is represented by a 3:1 plot ratio.[3] This is similarly indicated for nearby sites. Given changes in the cost and revenue curves, the values of these sites have increased since the time of initial development of the given site. In fact the value of the given site has increased to such an extent that the current improvements are effectively valueless.[4] Since establishment of business on the site the firm's floor space needs have increased so that twice as much space is required, and in the foreseeable future three times as much space as is currently used will be required. The businessman is now faced with at least three possible courses of action. He can:

1) purchase the adjacent sites and expand horizontally
2) rebuild and expand vertically on the given site
3) sell his current property and relocate.

Consider courses (1) and (2). The businessman will trade-off the costs involved between purchasing the adjacent (perhaps both) site and erecting a two (perhaps three[5]) storey building on his current site (searching for the most profitable course of action). In order to purchase the adjacent sites the businessman will have to compete with those interests which see a three storey building as being the normal

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1. As discussed in Chapter six.

2. As discussed in Chapter nine.

3. Assume this to be a three storey building which covers the site.

4. This concept of a change in site value over time and its implications for redevelopment is discussed in Chapter eleven.

5. And lease the unused space until required.

intensity of utilisation for the sites in question. If the businessman is unable to compete with these interests in the sense that it would be less costly to expand vertically on his present site, then it may be said that an increase in land value (specifically, as far as the businessman is concerned, of the adjacent sites) has led to an increase in the intensity of utilisation. In this matter another factor may enter the businessman's calculation. If he expanded horizontally and constructed a one storied structure across the two or three sites then, in terms of the current market for floor space, he would be underutilising each site. That is, he would not be reaping the maximum gains possible.[1] For one reason or another he may not regard it as being financially prudent to commit so much of his capital to a single property which optimally (in terms of profit maximisation) utilised the land (i.e. a three storied structure across three sites). Again it may be said that, due to the high cost of land the decision maybe to take little land (viz. his current property) and 'build high'.

Consider the third course of action mentioned above viz. the businessman may sell his property and relocate. The possibility will enter any trade-off options open to the businessman and, in fact, it is an example of the trade-off between site rent and location as discussed by Alonso.[2] If the increase in site values has been such as to indicate that his current improvements are in fact valueless (in terms of redevelopment[3]) than a possibility exists that the businessman

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1. In this case it would be in terms of leasing the available floor space.

2. Cf. above in Chapters one and two.

3. See the following chapter.

may simply sell his property and relocate in an area where the supply/demand interrelationship indicates that a less intensive site development is normal. In such an area land will be of a lower value and, since it is cheaper, a horizontal expansion there may be less costly than a vertical expansion in the current location. Any capital gains which the owner may obtain on the sale of his current property will be discounted against the less desirable (and less profitable) location of an alternative site.[1]

There is a highly complex feedback system between the 'micro' and 'macro' views of land value determination and the intensity of site utilisation. For instance, if the supply/demand interrelationship should alter, then the normal intensity of site utilisation and consequently site value will also alter. Now each production decision (for floor space) enacted by the businessman will alter (if only marginally) the supply/demand interrelationship.[2] Given sufficient change[3] the optimum land value and hence site rental bids will alter. This change in cost will again alter the businessman's decision options and so on . . . The following section analyses the manner in which, in a decision on the production of floor space, the site value (value of the land factor input) will alter as the intensity of site utilisation (capital/land substitution) alters.

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1. In this discussion can be seen the rationale behind the statement in Chapter five that those land uses which require a great deal of space may relocate on the periphery of the city where land is cheaper. Again here it may appear that at the micro level, that is from the point of view of the individual firm, land value determines land use. However when seen in the broader perspective it is clear that land use determines land value.

2. Given that this represents net construction and not simply replacement construction.

3. That is, to make the alteration between supply and demand distributions sufficient to bring about a rental change.

10.3 The Interaction Between Capital/Land Substitution and Land Values

It appears, then, that the controversy regarding land values and capital/land substitution (intensity of utilisation) may, in fact, be reduced to a 'micro' vs a 'macro' view of the problem.[1] As suggested in the previous section there is a feedback involved between the 'macro' and 'micro' view. This section examines one aspect of this feedback viz. the manner in which land value will change if capital/land substitution changes. The implications of increasing the land factor input will be examined under three sets of assumptions. The first case will consider a situation in which there is a relatively greater shift in the revenue curve as size category increases, the second case will consider a situation in which there is a relatively greater shift in the cost curve and the final case will consider a situation in which revenue remains unchanged.

At the outset let us construct an hypothetical isoquant showing various combinations of capital/land substitutions which may be utilised in the production of a given quantity of floor space. Suppose in the following diagram q' represents an isoquant for the production of 100,000 square feet of commercial floor space. Units of the land factor input are measured on the vertical axis while units of capital input are measured on the horizontal axis. Labour and entrepreneurial ability are ignored. If the following assumption is adopted the units of capital input may be expressed in terms of building height. Let the building completely cover the site. Therefore each unit of land

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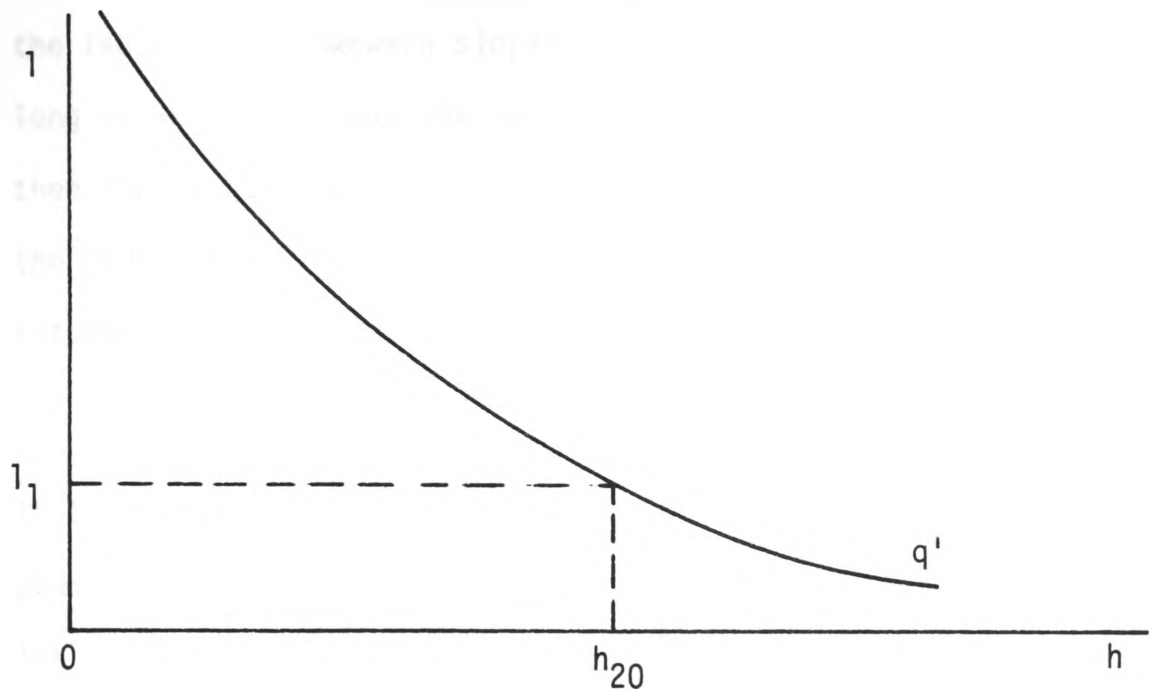
1. I am indebted to Dr. Brian Bentick for the suggestion that this may be the case.

Figure 10.1



input will also represent the floor space constant factor θ (if area lost in wall thickness etc. is ignored). Now, to read the diagram, suppose each unit of land (l) is 5,000 square feet. If 1 unit of land is utilised then θ = 5,000 and 20 units of capital (h) are required. This simply means that a building of 20 storeys needs to be erected if 100,000 square feet of floor space are required and where horizontal expansion is limited to 5,000 square feet. Other points on this isoquant may be read in a similar manner. The isoquant does not cut either axis since some land and some capital is needed to produce the floor space. Now if

$$q = F(h,l) \text{ which is constant}$$

and $$dq = \frac{\partial F}{\partial h}.dh + \frac{\partial F}{\partial l}.dl = 0$$

the slope is

$$\frac{dl}{dh} = \frac{-F/\partial h}{F/\partial l}$$

and as long as

$$\frac{\partial F}{\partial h} > 0 \text{ and } \frac{\partial F}{\partial l} > 0$$

the isoquant is downward sloping. That is, in a standard manner, so long as we assume that the marginal product of each factor is positive then the isoquant will be downward sloping. If it can be supposed that the developer is operating under conditions of diminishing marginal returns then the isoquant will be convex to the origin.

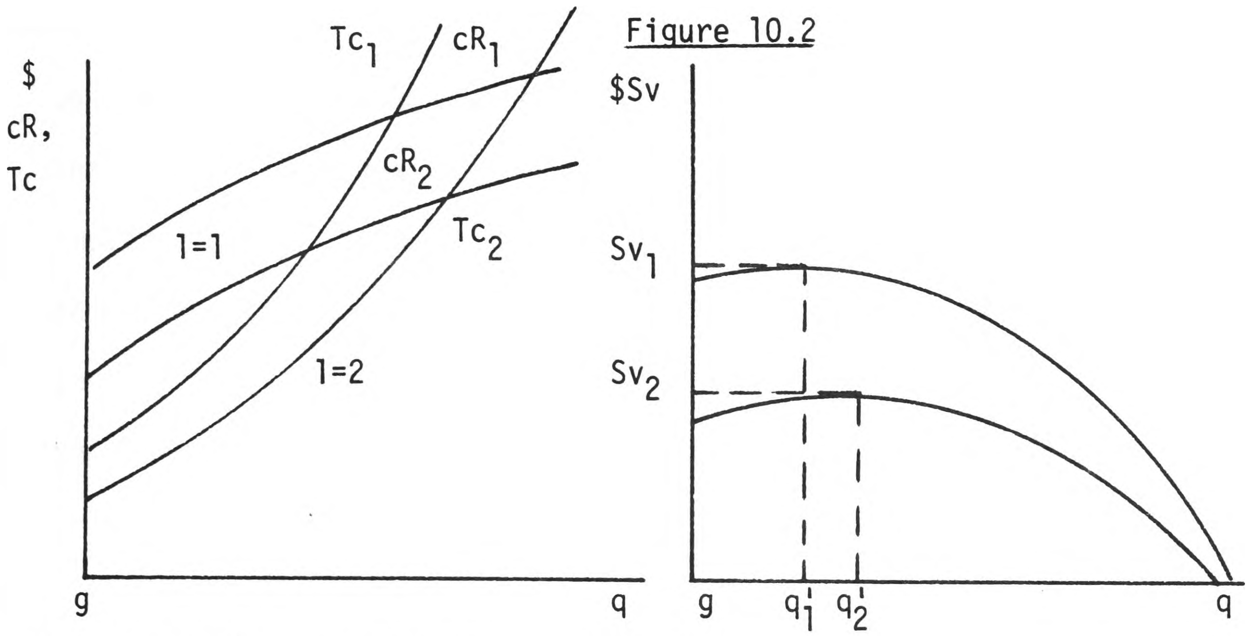
Now, as a first case, let us assume a lower modal distribution such that tenants in the upper size categories have a high degree of bargaining power and that θ also represents the size category maintained throughout the building. What will be the effect if increasing units of the land factor input are applied? This may be shown in the following diagram. Suppose the factor combination h = 20 and l = 5 represents an optimum (profit maximising) position. Furthermore, suppose the following factor substitutions (for q = 100,000) are made:

TABLE 10.1

l	θ	h	σ' = 500[1]
1	5,000	20	10
2	10,000	10	20
3	15,000	7[2]	30
4	20,000	5	40
5	25,000	4	50

1. Ignore this column for the present.
2. Approximately 7.

Figure 10.2



Let q' denote q' = 100,000 square feet.

The Tc curve is, once again, exlusive of the land cost component. At the factor combination h20,11

$$\frac{\partial cR_1}{\partial q'} = \frac{\partial Tc_1}{\partial q'}$$

Now, suppose the factor combination h10,12 is applied to produce q'. This is shown in the above diagram as the point q_2'. From previous analysis it is known that, at the point q_2'

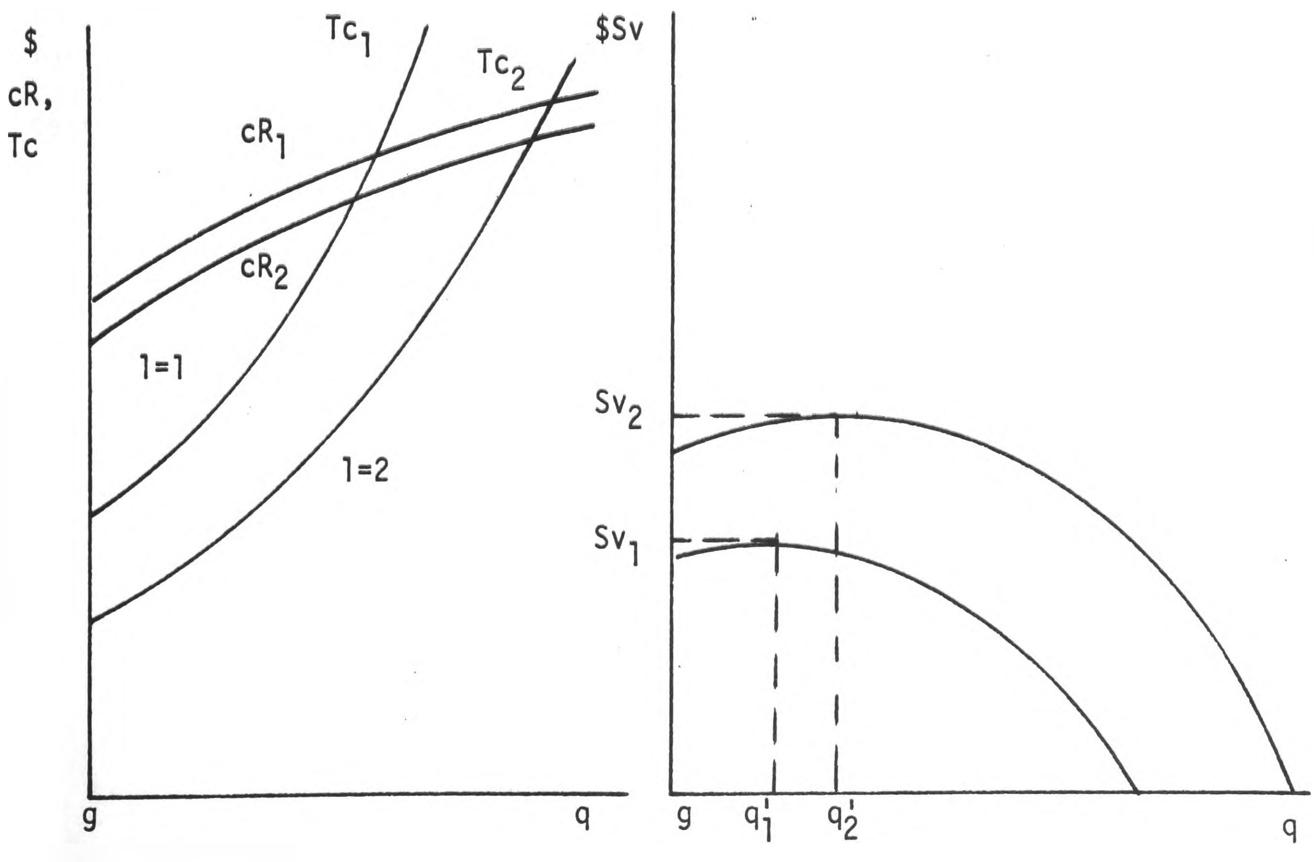
$$\frac{\partial cR}{\partial q'} > \frac{\partial Tc}{\partial q'}$$

That is, it may be said that since marginal revenue is greater than marginal cost in the production of q_2' then h10,12 is not an optimum factor combination in this case. Although h10,12 is a factor combination which maintains q', if the factor l is increased then, under this set of assumptions, the optimum factor combination also requires an increase in the factor h. That is if l is increased q' is no longer an optimum quantity of floor space and an increase in intensity of site utilisation is necessarily implied. A further implication, which follows from previous analysis, is that factor combination hn,12 resulting in q which is greater than q' will bring about a decrease in site value. That is, in the above diagram, since $(cR_1 - Tc_1) > (cR_2 - Tc_2)$ it implies that $Sv_1 > Sv_2$. (However, if factor combination h10,12 is maintained to produce q' then (a) intensity of utilisation will decrease and (b) site value will fall. This will be so since, by definition h decreases and by assumption there is greater relative movement in the revenue curve).

As a second case suppose there is a relatively greater movement in the cost curve. As in the previous case since marginal costs at each height will decrease this necessarily implies an increase in intensity of utilisation for optimisation, but unlike the previous case site value will here increase. This may be shown in Figure 10.3. Here with factor combination h20,11 (θ = 5,000) assume

$$\frac{\partial cR_1}{\partial q'} = \frac{\partial Tc_1}{\partial q'}$$

Figure 10.3



At factor combination h10,12 (θ = 10,000) $(cR_2 - Tc_2) > (cR_1 - Tc_1)$ which implies that $Sv_2 > Sv_1$. Also

$$\frac{\partial cR_2}{\partial q'} > \frac{\partial Tc_2}{\partial q'} \qquad \text{at } q_2'$$

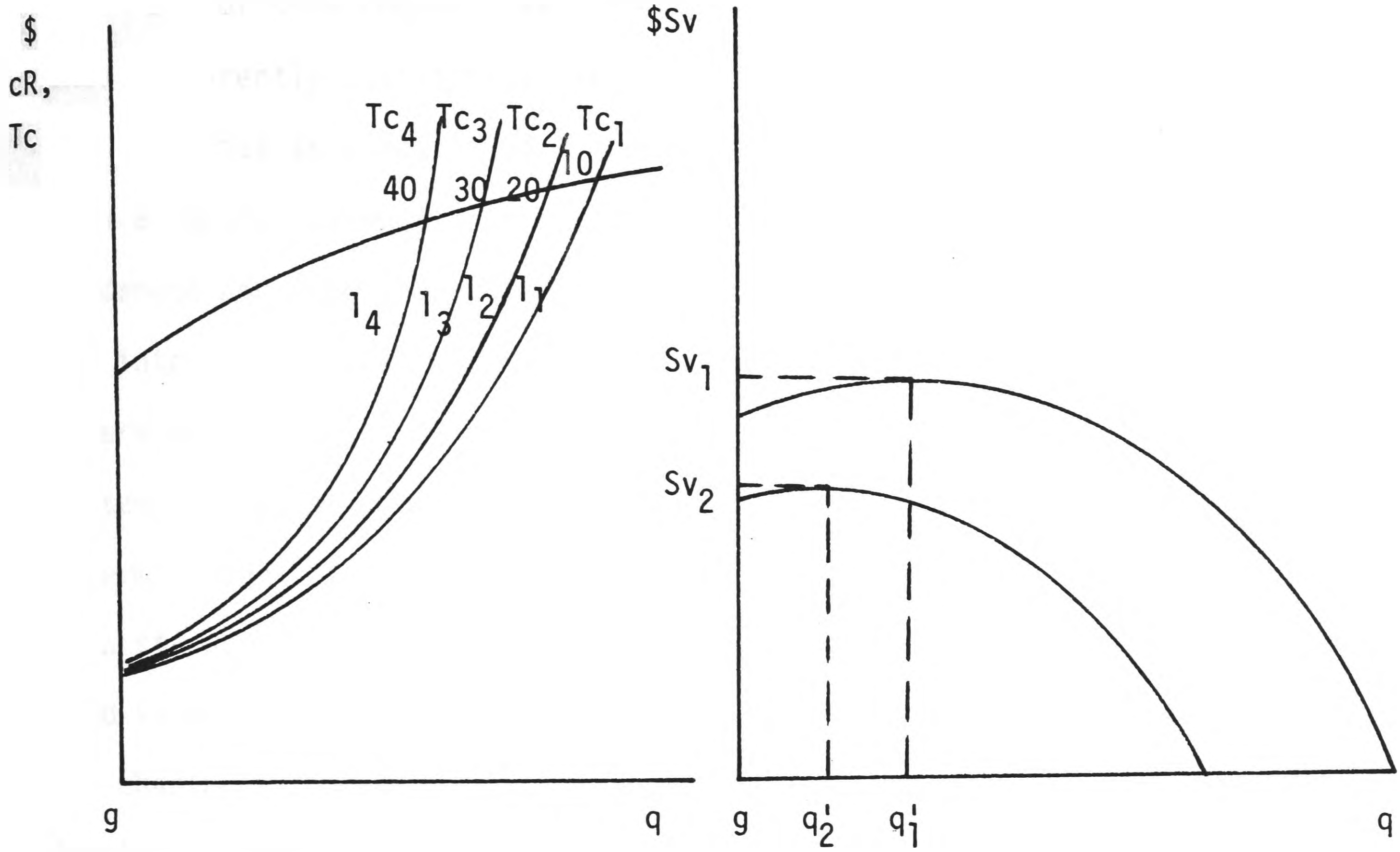
which implies a move to some $q > q'$. If 12 is held constant this implies an increase in h. Clearly, if the revenue curve should shift upwards as size category increases the results will be similar.

As a final case consider the situation where size category (σ') is maintained as θ changes (so that bargaining power structure is irrelevant) and where the costs of subdivision in order to maintain σ' are greater than the cost savings associated with a larger θ. In this situation the revenue curve will remain unchanged as the factor 1 is increased. Now, as the factor 1 is increased the cost function will pivot upwards, as shown in Figure 10.4. Here since

$$\frac{\partial cR}{\partial q'} < \frac{\partial Tc_2}{\partial q'}$$

at q_1' it implies a decrease to some q which is less than q_1'. Furthermore, since $(cR - Tc_2) < (cR - Tc_1)$ it implies that site value will decrease as the land factor input increases.

Figure 10.4



10.4 Conclusion

The present chapter has attempted to deal with the problem of the direction of causation between land values and capital/land substitution. In previous chapters it was indicated that site value will depend on the demand and supply factors which determine the position of the revenue and cost curves. The present chapter, however, indicated that the matter may not be that simple. It was suggested that two conflicting notions appeared to exist in the literature: On the one hand it was argued that land values depend on the intensity of site utilisation; on the other hand, another 'school of thought' appeared to argue that land values determine the intensity of land use.

Part of this chapter has been concerned with attempting to reconcile these apparently conflicting views. It was suggested that the differing notions arise as a result of a 'macro' vs a 'micro' view of the problem. From a 'macro' viewpoint site values will depend on the broad forces of demand and supply operating within the city. Such forces determine the intensity of utilisation of any given site, and consequently, determine land values. From the viewpoint of the individual firm contemplating, say,building expansion, it may appear that land values determine the intensity of utilisation. It was suggested that there is a strong 'feedback' system between these broad and narrow views of land value determination. Given that such a 'feedback' system exists the chapter examined the manner in which the value of the land factor input will change if capital/land substitution changes.

SUMMARY AND CONCLUSIONS

Summary and Conclusions

This analysis of the central business district property market was instigated, in the first instance, by what appeared to be an inefficiency in the market mechanism. At least this was the writer's first reaction to the growth in the quantity of vacant commercial floor space in the central business districts of Australian cities at a time when residential floor space appeared to be in relatively short supply. Wollongong was chosen as a case study area as its size in particular (amongst a number of reasons) made it possible to undertake a detailed study of the property market in an attempt to better understand the market mechanism.

It was at first thought that a model (simulating the characteristics of the market)may have been an appropriate tool. However, this was felt not to be the case for two interrelated reasons:

1) An analysis of the Wollongong property market based on accepted ('conventional') theory of land value determination showed that this theory failed to explain the pattern of values observed over a long period in Wollongong and (there was also a strong presumption) in other local and regional markets;
2) The literature seemed to offer little in the way of either establishing what may be regarded as a normal (profit maximising) committment of capital to a site in the central business district, or, in specifying the relationship between the quantity of capital committed to a site and the value of that site. In fact, at a superficial level, it appeared that the literature had two opposing schools of thought on this latter point.

These interrelated problems formed the basis of the entire research since it was felt that failure to deal adequately with these would ensure that any subsequent research on the property market would tend to be of only limited value.

Part I of the thesis, then was concerned with outlining 'conventional' land value theory and with demonstrating the gross disparity between the actual and the expected (i.e. based on accepted theory) patterns of land values. With regard to this latter point it was observed that the divergence was particularly acute when the unit of analysis was relatively small. From this it was apparent that location with regard to the focal point of the CBD was not an important factor within these small units of analysis. This led the writer to suggest that, as a general observation, areas of similar locational desire appeared to exist within which the firm was indifferent to location in relation to the PLV site. It was felt that, other things being equal, the street block may be regarded as a first approximation to an area of similar locational desire. The analysis in Chapter three indicated that, within the street block, location with respect to the PLV site was, in fact, unimportant. Now, within the context of such a notion as an area of similar locational desire this may be quite expected and, other things being equal, one may expect relatively little land value variation. However, in Chapter three it was demonstrated that there was substantial variation in land values within the street block which could not be explained by corner location or size of site (i.e. apart from location with respect to the PLV site). In fact, in relation to size of site and land value it was found that a positive, or a negative or no relationship may exist. Such a result was contradictory to conventional theory.

In Part II the street block was taken as the basic unit of analysis. Chapter four was concerned with delimiting the area known as the central business district. A technique similar to that utilised by Murphy and Vance was adopted in the current work. In both the Murphy and Vance study and the present one the street block was the basic unit of analysis. Apart from delimiting the study area Chapter four performed the very basic, but essential task of describing the central business district, particularly in terms of the land use, tenancy and ownership status. Amongst other things this served to provide the reader with background information useful in later analysis. Chapter five was particularly useful in helping to demonstrate that street block submarkets existed within the central business district and, as such, provided some support for the notion of areas of similar locational desire. Evidence for the submarket concept was provided by the fact that certain land uses appeared to compete consistently for floor space at the street block level across the central business district.

In attempting to understand the disparity in land values shown to exist in Chapter three, then, the real property market was examined a little more closely. A characteristic of real estate is that it is immobile and hence floor space must be produced and consumed at a given location. Partly for this reason analyses of the property market have tended to assume that the goods (floor space) demanded and supplied were simple and easily observed and that buyers and sellers knew of a continuum of substitutable goods (land and location) in a national, state or local market. In this market (at least in the Wollongong case) each buyer and each seller tended to be a specialist, and only an approximation to a match between a seller's offer of specified goods and a buyer's demand for specified goods was possible.

Under these conditions, then, it appeared that the actual system approximated more closely a bargaining model than the model of market competition supposed in conventional theory. A bargaining model, based purely on the supply of floor space in relation to the demand for that space was developed in Chapter six. The argument was simple. If the supply of a certain sized floor space was excessive, then this placed the tenant (utilising this size) in a position to demand a lower per unit rental than it would be possible for another tenant to obtain (with a size of floor space whose supply was not excessive). The potential of the model was explored under a variety of landlord/tenant (supply/demand) positions. For instance, for simplicity the bargaining structure was broadly classified according to whether a 'lower modal' or an 'upper modal' distribution prevailed. Briefly, it was demonstrated (theoretically) that if a lower modal distribution existed, then tenant bargaining power would increase as size category increased (consequently, per unit rents would decrease). It was also shown that opposite results would ensue if an upper modal distribution prevailed. The limited type of data available for testing gave support to the model.

To incorporate the problem of capital/land substitution into the analysis Chapters seven and eight developed abstract models of revenue and cost determination for individual properties. The basic structure of these models was supported by the available empirical evidence. The behaviour of these models, particularly as bargaining power and location varied, was then explored and it was shown that:

1) If tenant bargaining power increased as size category increased then the revenue function would be lowered but marginal revenue would remain unchanged (the opposite result was shown to prevail for an upper modal distribution);
2) Within a given size category, as distance from the PLV site increased (i.e. from one SLD area to another) the revenue function would be lowered and marginal revenue would decrease for any given level of development;
3) A general increase in the vacancy rate would lower the revenue function but would leave marginal revenue unchanged;
4) An increase in the vacancy rate on the upper floors relative to the lower floors would cause marginal revenue to decrease at any given level of development;
5) If floor space is supplied in the lower size categories rather than the upper, marginal cost will be greater at each level of development;
6) As distance from the PLV site increased marginal costs at each development level would remain unchanged.

These results, in conjunction with the particular functional form of the revenue and cost curves, were utilised in Chapters nine and ten in order to examine the effects of variations in bargaining power on the efficiency of land and capital use and, in particular, capital/land substitution. The manner in which intensity of utilisation varied as bargaining power varied was closely examined. It was found, inter alia, that in those situations where per unit rents decreased with building height and where the relative bargaining strength tended to rest with those tenants utilising large undivided quantities of floor space, the intensity of utilisation would be less than where the bargaining power rested with those landlords supplying large undivided quantities of space. This suggested, for instance, that if the distributions of floor space sizes, and tenant optimum floor space requirements are such that tenant bargaining power increases as size category increases, then the city sky profile will be relatively low. On the other hand, the process of optimum utilisation of capital is such that the CBD sky profile would be relatively high if an upper modal distribution prevailed. It was argued that since the bargaining power structure would tend to fluctuate over time, this implied that at any given moment in time the CBD sky profile may be expected to be highly varied. It was also argued that a falling sky profile, towards the periphery of the CBD, was also a necessary consequence of the pursuit of efficiency in capital use within the constructs of the model.

Chapter ten considered the problem of whether land value was determined or was determining with regard to intensity of utilisation. The literature appeared to produce two conflicting conclusions in this respect. However, in Chapter ten it was argued that it really depends on whether a 'micro' or a 'macro' viewpoint is adopted. From the point of view of the individual firm (considering committment of capital to a given site) it was shown that land value may appear to be the influencing factor. However it was argued that any given revenue curve will depend on demand (and supply) factors throughout the city and the cost curve will depend not only on conditions in the building industry but also in other sectors. Thus, it was argued, in this 'macro' sense land values were determined rather than determining. Chapter ten also utilised the thesis model to examine the impact on land value as capital/land substitution changed. Three assumptions of bargaining power structure were individually considered. Firstly, it was shown that if tenant bargaining power increased as size category (i.e. size of undivided floor space exchanged) increased, then an increase in the land factor input would result in an increase in intensity of utilisation and a decrease in maximum site value, if profit maximising principles were followed. On the other hand, it was demonstrated that if tenant bargaining power decreased as size category increased, then an increase in the land factor input would result in an increase in intensity of site use and an increase in site value. Finally, it was shown that if bargaining power remained unchanged as size category increased, then an increase in the land factor input would result in a decrease in intensity of utilisation and a decrease in site value.

Taken together, then, Chapters six through ten (constituting Part III) have dealt satisfactorily with the thesis problems viz. 1) a model has been constructed which is capable of explaining land value variation in areas of similar locational desire. It has achieved this by incorporating into the analysis differences in degree of bargaining power between landlord and tenant; 2) the relationship between site value and commitment of capital to a site has been precisely specified, but more importantly the influence of bargaining power on efficiency of capital use has been analysed. This latter part of the study in particular has produced the interesting and useful results described above.

The conclusions described above were shown logically to fit a particular case (Wollongong) but they also appear to have some general significance because the conditions described have been observed in the literature but often not incorporated in economic analysis (refer, for example, to the rigidities described by Richardson and Turvey, the bargaining power factors discussed by Barlowe, cost factors discussed by Bathurst, Klaber and others, and demand factors analysed by Blank, Winnick, Grebler and others).[1]

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1. As cited in the body of the thesis. Refer to the Bibliography in Appendix G.

Where the determination of intensity of utilisation (and, consequently, land values) is not efficient (or not acceptable) then planning may achieve efficiency in land use by marginal social opportunity cost effectiveness criteria. However, the extent to which the present analysis may be utilised by the planning authorities is constrained by the limited nature of the enquiry. One of the most serious drawbacks in this regard may be the relatively low priority assigned to demand factors. This in no way implied that demand was considered to be unimportant (clearly, demand is important). However, due to time and space constraints it was necessary to impose some limitations. Throughout the analysis, then, demand was simply assumed to exist, to change, or to remain the same, whatever the case required. No reasons were proffered as to why demand behaved in this way. Consequently, this may be regarded as a starting point for further research. Appendix B provides some indication of the importance of demand. Another area which needs further consideration (i.e. before the model developed may be considered to be a highly useful planning tool) is the interrelationship between land values in the CBD and the region. Again, a brief statement is provided on this in Appendix B. Clearly, then, the model as it currently stands would tend to have a restricted role as a planning instrument. Its chief usefulness would lie in the provision of a guide as to market behaviour (with regard to intensity of utilisation).

APPENDICES

APPENDIX A

QUANTITATIVE RESTRICTION AS A MEANS OF SITE DEVELOPMENT CONTROL

There is one measure of control in vogue throughout Australia and overseas that has been designed exclusively for site development control. This is a quantitative restriction instrument commonly termed plot ratio control. Plot ratio may be defined simply as the ratio of floor area to site area and a plot ratio may be specified for any, or all, of the following reasons:

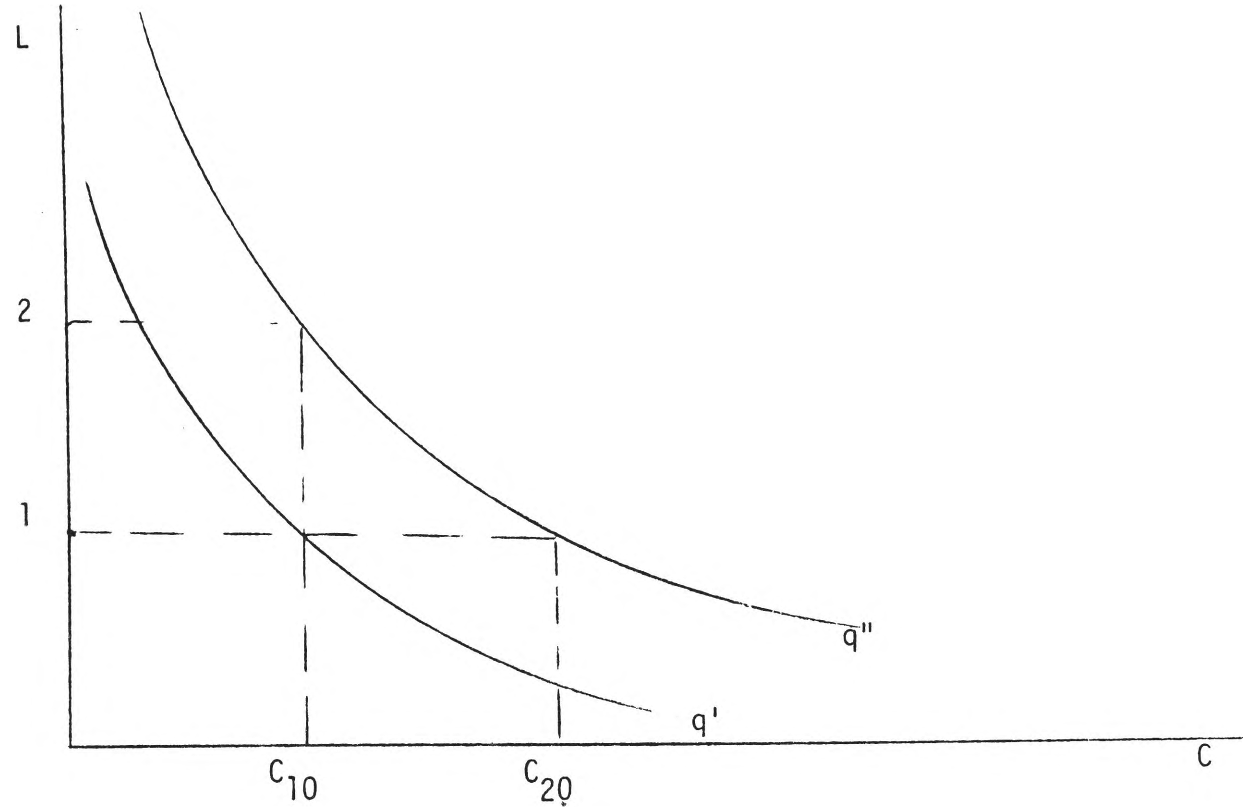
(a) to prohibit an inequitable distribution of light and air amongst residents and users (especially of the central business district),

(b) to retard road congestion by limiting business opportunities (or residential opportunities) in a particular area,

(c) and therefore, indirectly, to encourage business (or residential) development in alternative areas.

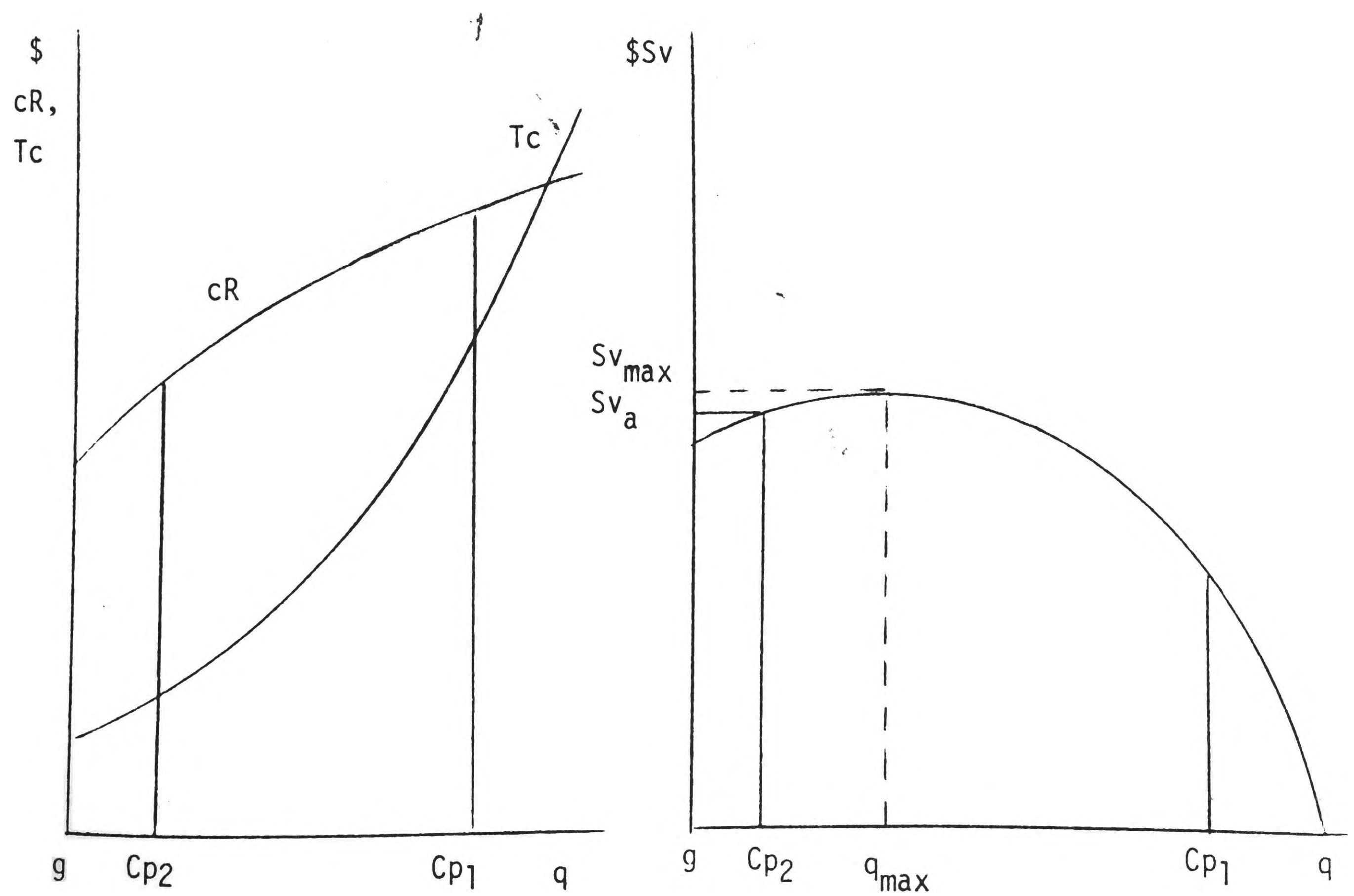
For any given site the plot ratio places a ceiling on the quantity of capital which may be substituted for land as shown in Figure A.1. Here it has been assumed that the capital/land substitution constraint has been specified at 10 units of capital to 1 unit of land. Thus, if the floor area on each floor is equivalent to the site area, then a maximum 10 storey development is allowable. Or, if the floor area is equivalent to half the site area, a maximum 20 storey development is allowable and so on . . . Now, let us examine the effect on site value. The first constraint represents a floor space restriction which is greater than the optimum quantity of floor space required (q_{max}) and therefore has no effect on the maximum site value (Sv_{max}). This may often be the case in an 'immature' business district where the primary demand is for

Figure A.1



In Figure A.2 two plot ratio constraints, Cp_1 and Cp_2, have been introduced.

Figure A.2



a ground floor location and where there is a rapid fall off in rental with height. The second constraint, however, is less than q_{max}. In this case an artificial site value is created (Sv_a) which is less than the maximum site value obtainable. This will always be so unless the revenue and/or cost curves alter in such a manner that the point (q_{max},Sv_{max}) is moved to the left and downwards. For any given plot ratio constraint, as the bargaining power of upper category landlords increases, or, as the demand for upper floor locations increases, the greater will be the impact on site development and site value of that constraint.

APPENDIX B

THE DEMAND FOR FLOOR SPACE

B.1 Approach Adopted in Thesis

Throughout the analysis often implicit, and certainly only relatively infrequent, reference has been made to the demand for commercial floor space. The basis of the demand, and the factors causing this demand to remain stable or to change, were simply assumed to exist. For instance, the bargaining model was merely said to depend on the demand for commercial floor space, in relation to the available supply of the space, in particular size categories. In the development of the model it was usually simply 'supposed' that demand may alter in favour of a larger or a smaller size category. Little attention was given to the reasons for demand alteration, or to the process of land use succession.

A mild exception to this lack of attention to the subjective and behavioural basis of demand was provided by Chapter five, which considered the competition amongst land uses for available floor space. However, this discussion ceased well short of a complete analysis of demand.

There was a basic reason for this approach. It was convenient for development of the model, and the approach in no way influenced the results of the analysis. Demand was assumed to exist and to remain stable, or to change - the reasons for it so doing were inconsequential within the close framework of the analysis. This is not unlike the approach adopted by Ricardo and the post-Ricardians who, being particularly concerned with land, have studied the supply of this factor under varying conditions of demand.[1] This does not imply that demand factors are unimportant. For instance, it may be said that Jevons and the post-Jevonians have concentrated on demand[2]. However, it was felt that there is still a need for specialised study of conditions of supply under given (constant or changing) conditions of demand.

B.2 Factors Influencing Demand

Nevertheless the present analysis would tend to be incomplete without some consideration of the factors influencing the demand for floor space. This appendix looks briefly at such factors and at the process of land use succession.

When assessing the demand for commercial floor space one may look, in the first instance, at national factors. Here, as Jennings has pointed out "National economic growth is the most obvious influence at work".[3] Government policies which stimulate the economy will have a profound influence on the demand for accommodation, since a thriving business community requires such accommodation.

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1. Cf. Hartwell, op.cit.

2. Cf. Collison Black, R. D. Jevons - The Theory of Political Economy, Penguin, Ringwood, 1970. It may be noted that Marshall considered both demand and supply sides of the equation. Cf. Guillebaud, op.cit.

3. Cf. Jennings, C. R. "Predicting Demand for Office Space", Appraisal Journal, July, 1965.

On a more reduced scale the economic base of the local area will have a significant influence on the demand for accommodation in the CBD.[1] For instance, Jennings has suggested that ". . . cities whose industrial base is predominately in manufacturing[2] generally will have few downtown offices, since most of the offices will be attached to the manufacturing plants".[3]

Also, the regional importance of the city will have an important impact on the demand for commercial floor space in the CBD. That city which may be regarded as of prime importance in the region (or state, or nation) will attract the headquarters - the 'flagships' so to speak - of various firms. There will be a number of other firms attracted to the CBD in order to locate near these 'flagships'.[4]

The quantity of accommodation required in the CBD depends on the size and type of region which a city serves.[5] Smith has suggested approximations for floor space requirements within a metropolitan area (Table B.1) but agrees that it would be difficult to allocate a specific proportion to the CBD since this will depend on local influences at work.[6]

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1. An excellent discussion of the economic base concept is provided by Andrews, R. B. "Mechanics of the Urban Economic Base: Historical Development of the Base Concept" and "Mechanics of the Urban Economic Base: The Problem of Terminology" in Land Economics, Vol. 29, 1953.

2. Such as Wollongong.

3. Jennings, op.cit., p. 379.

4. A similar notion was put forward in Chapter 6 in relation to the two 'levels' of bargaining. There it was suggested that firms firstly demand floor space in the CBD as such, and then seek a particular area in the CBD.

5. Jennings, op.cit., p. 379.

6. Smith, L. "Space for the CBDs Functions", Journal of the American Institute of Planners, Vol. XXVII, No. 6, 1961, p. 36.

TABLE B.1

Metropolitan Per Capita Floor Area Requirements for Selected Activities

Activities	Floor Area Per Capita (sq.ft.)
Retail	20-55
Office	2-15
Parking	4-16
Public	1-3.5
Quasi-Public	1-3.5
Wholesale	5-15
Industrial	2-15
Residential	200-400

Clearly, as a city grows there will be an increase in the demand for commercial accommodation throughout the metropolitan area, including the CBD. This demand will arise not only from firms entering the area, but also from the growth of already established firms.[1]

B.3 Land Use Succession

The size and type of the area which a city serves is seldom constant through time. A consequence of this change may be an alteration of the land use pattern in the CBD (i.e. an alteration in the demand for specific types of floor space). As the potential market area[2] of the city increases higher order activities will demand accommodation in that location which can best take advantage of the entire market area, and this location is often the CBD.

1. This was implied in Chapter six when it was assumed there may be alterations in the optimum floor space requirements of firms.

2. This notion of a potential market area was discussed in Chapter five above.

This alteration in the demand for particular types of accommodation implies that some properties will become obsolete in their current uses. In other words property resources will move to those uses which offer the highest return for their utilization. This may be called the process of land use succession and it has been described succinctly by Barlowe as ". . . whenever changes in the effective demand for different types of land use lead to changes in the use capacities of the lands available for these uses, the land resources in question tend to shift to their highest and best economic uses unless prevented by institutional barriers, contrary goals, or individual inertia".[1] Examples of land use succession are manifold:[2] service station sites may be redeveloped for retail stores; corner stores may be redeveloped for office complexes, and so on . . . The process is dynamic though it may be slow.

Although the demand base (the potential market area) is constantly changing, land use succession will not occur until it is profitable.[3] In this regard the capitalised net income streams of the alternative land uses will be compared for profitability. When the capitalised net income of a property in a new use exceeds that in the current use (including the capital loss in writing off existing property structures) the current use is ready to be superseded.

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1. Barlowe, op.cit., pp. 219-220.
2. Examples of land use succession in the Wollongong CBD were given in Chapter four, especially pp. 82-84.
3. This is not strictly true since non monetary factors, such as prestige, personal power/glory etc., may be the motivating force. Whether the goal is monetary or non monetary it may be assumed that the developer has a positive benefit/cost calculation.

B.4 The CBD and the Region

The thesis at large paid scant regard to the CBD's role in the region. In fact, much of the analysis implicitly considered the CBD as a closed system. This is far from realistic, although the approach suited the conceptual needs at hand. Nevertheless, a more complete piece of research on land values and the market for commercial floor space would need to consider a CBD integrated with, rather than distinct from, the city/region it serves. The CBD is the heart of the region and most changes in the region will have some impact on the CBD.

Section B.2 considered some changes which may occur and which will have an upward impact on the demand for floor space, and consequently an upward impact on land values (ceteris paribus), in the CBD. Let us consider some changes which will operate in the opposite direction. Prior to the advent of the automobile the CBD was unchallenged as the goods retailing as well as service retailing core of the region. However over the past few decades the automobile has made an enormous impact on the demand for floor space in many CBDs. For instance inadequate parking facilities in the CBD and the inability of the transportation network (public transport on the one hand, and the road system on the other) to cope effectively with the traffic demand, coupled with increased mobility of the consumer, has spawned and nurtured the regional shopping centre, with its one stop shopping facilities and enormous parking capability. In a similar vein Sternlieb has argued

> The decline of retailing downtown is a concomitant of deep seated changes in residential and transportation patterns that are not likely to be reversed by attempts to revitalize the central business district. At the same time, shopping has lost much of its allure as a leisure time activity: shoppers place a premium on convenience rather than the widest possible choice of merchandise.

> New suburban outlets, well suited to the demand for easy auto access and quick shopping, constitute formidable competitition for downtown.[1]

The growth in the regional centres represents an effective loss of potential retail floor space demand from the CBD. But the impact of suburban sprawl is related not only to retailing. A study by Kasarda found that "Both cross-sectional and longitudinal analyses demonstrate that the suburban population has a large impact on central city retail trade, wholesale trade, business and repair services, and public services provided by central city governments".[2]

Apart from such non compulsory redirection of potential floor space demand from the CBD, the central city area may also be the subject of a specific decentralization policy. For instance such a policy was introduced by the London City Council in 1957. The Council felt that the continued growth of offices in the central area of London represented a threefold danger:

> first, the increasing stress on community facilities would lead to an over crowded public transport system and worse strain on roads; second, congestion in the centre itself would increase because of the traffic generated by offices and associated uses; and thirdly, offices were replacing other land uses in central London.[3]

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1. Sternlieb, G. "The Future of Retailing in the Downtown Core", <u>American Institute of Planners Journal</u>, Vol. 29, 1963, p. 102.

2. Kasarda, J. D. "The Impact of Suburban Population Growth on Central City Service Functions", <u>American Journal of Sociology</u>, Vol. 77, No. 6, 1972, p. 1111.

3. Hall, R. K. "The Movement of Offices from Central London", <u>Regional Studies</u>, Vol. 6, p. 385.

Again, any such explicit policy will result in a loss of effective potential demand for commercial floor space from the CBD. This necessarily implies that, ceteris paribus, the intensity of land use in the CBD, and consequently the level of land values, will be lower than would otherwise have been the case.

Clearly then, in any assessment of the future demand for floor space one must take into consideration the fact that the CBD is part of a much broader system.[1]

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1. As much as the approach in this thesis has been one of simply assuming demand to exist, and to change, this - as has been pointed out to the author by Dr. R. Knight - represents but one aspect of appreciating the problem of resource allocation in the urban area. There is a great deal yet which needs to be known about the operation of the market mechanism in this field. Unless our planners, and developers, are fully apprised of the processes involved, our urban resources will continue to be allocated in a manner which produces, for instance, an oversupply of commercial floor space at the same time that residential floor space is inadequate to meet demand. Consequently the current research represents a point of departure for further study, in particular, for research which will consider the basis for demand, and factors which will influence the demand for various types of floor space.

APPENDIX C

COMPUTER CODING FOR VALUER GENERAL DATA

Card 1

Columns	Information
1 - 9	Street and building identification. Utilised on each card
11 - 13	Street frontage
15 - 20	Site area
22 - 23	Owner code
25	Location code
27	Tenancy status code

Cards 2 and 3

11 - 17	Unimproved capital value)	This sequence then
19 - 25	Improved capital value)	repeated for the years
27 - 31	Assessed annual value)	1962, 1967 & 1972.

Card 4

11 - 12	Year of first sale)	This sequence then
14 - 20	First sale value)	repeated for each sale.

Cards 5 and 6

11 - 15	Basement floor space	1958)	
17 - 21	Ground floor space	1958)	This sequence then
23 - 27	First floor space	1958)	repeated for the years
29 - 33	Second floor space	1958)	1962, 1967 & 1972.
35 - 39	Third floor space	1958)	
41 - 45	Other upper floor space	1958)	

Cards 7 and 8

11 - 14	Basement rental	1958)	
16 - 19	Ground floor rental	1958)	This sequence then
21 - 24	First floor rental	1958)	repeated for 1962, 1967
26 - 29	Second floor rental	1958)	& 1972.
31 - 34	Third floor rental	1958)	
36 - 39	Other upper rental	1958)	

APPENDIX C (cont'd)

Card 9

Columns	Information		
11 - 12	Original owner code	)	
14	Owner location code	)	This sequence then
16	Tenancy status code	)	repeated for each sale.
18 - 19	Year of first sale	)	

APPENDIX D

COMPUTER CODING FOR LAND USE

Cards 10 and 11

Columns	Information			
1 - 9	Street and property identification (utilised on each card)			
11 - 14	Basement use	1958	)	
16 - 19	Ground floor use	1958	)	This sequence then
21 - 24	First floor use	1958	)	repeated for the years
26 - 29	Second floor use	1958	)	1967 and 1972.
31 - 34	Third floor use	1958	)	
36 - 39	Other upper floor use	1958	)	

APPENDIX E

QUESTIONNAIRE TO DEVELOPERS, ARCHITECTS AND BUILDERS

Information Required	1-4	5-10	11-18	19-28	over 28
	Proj. 1	Proj. 2	Proj. 3	Proj. 4	Proj. 5
a) Year of completion					
b) No. of storeys					
c) No. of rentable sq.ft. i.e. exclusive of corridors, etc.					
d) No. of gross sq.ft.					
e) Size of site (sq. ft.)					
f) Cost of site					
g) Total construction costs (exclusive of site costs)					
h) Costs attributed to building shell (foundations, structural materials and covering materials					
i) Costs attributed to all other materials					
j) Costs attributed to labour					
k) Construction material used (reinforced concrete, structural steel, etc.)					

(Column heading: Range of storeys in each project)

APPENDIX E (cont'd)

Information Required	Range of storeys in each project				
	1-4	5-10	11-18	19-28	over 28
	Proj. 1	Proj. 2	Proj. 3	Proj. 4	Proj. 5
l) Time taken from commencement to completion					
m) If possible the name of the City or town where the project was undertaken					
n) Estimated total rent per annum					
o) Estimated net rent per annum					

APPENDIX F

TRANSLATION CODES UTILISED

Information	Code
Owner Type	
Public company and wholly owned subsidiary	1
Private company	2
Partnership	3
Single proprietor	4
Government (Federal, State, Local)	5
Other (Churches, Charitable Organisations etc.)	6
Owner Location	
Wollongong Statistical District	9
Sydney and Suburbs	8
Interstate	7
Other NSW	6
Tenancy Status	
Owner Occupied	1
Owner Occupied with Tenants	2
Completely tenanted	3
Government	4
Other	5
Vacant Building	6
Vacant Land	7

APPENDIX G

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APPENDIX H

COMPUTER PROGRAMME DESIGNED FOR PARTIAL ANALYSIS OF VALUER GENERAL DATA

T WILSON VS PROGRAM

```
      INTEGER HEADER(13),SAREA(40),STRTNO(40),ICV(4,40),
     1        UCV(4,40),FLRSP(4,7,40),RENT(4,7,40),
     2        LOCDE(3),TENCDE(3),OWNCDE(9),ORIGTC,ORIGLC,ORIGTN,
     3        BLKCNT,NOINBK,STCODE,STFRNT(40),OWNER(40),LOC(40),
     4        TENURE(40),HDCHK,AMAL(40),IYEAR(40,3),SVAL(3),NOIRET(4),
     5        NORENT(4,7),TOTFLR(4,7),SVALYR(4),TRENT(4,7),
     6        UVSUB,CRI(4),DUMMY(13),HDCHK2
      INTEGER CTAB(16,700),YOS(5),OWN(5),LOCN(5),TEN(5),
     -        CTYNPU(15),CTYNPI(15)
      EQUIVALENCE (HDCHK,HEADER),(HDCHK2,DUMMY)
      DIMENSION THI(4),PCRET(4,6),PCSUM(4,7),PSUMSQ(4,7)
      REAL II(4),IRSUM(4),IRSSQ(4),IRET(4),CTYSVU(15),CTYSVI(15),
     -     CTYSAU(15),CTYSAI(15),CTYSFL(15),TOTICV(4,6),TOTOSA(4,6),
     -     BLKICV(4,6),BLKOSA(4,6)

      DATA SVALYR / 58,62,67,72 /

    1 READ 10,HEADER
   10 FORMAT(13A6)

C EVERY HEADER CARD FOR EACH BLOCK MUST CONTAIN "*1    " IN THE FIRST
C 6 CHARACTERS. 6 BLANK CHARACTERS SIGNIFY THE END OF DATA.

      IF(HDCHK.EQ.'*1    ') GO TO 15
      IF(HDCHK.EQ.'      ') GO TO 705

      PRINT 13,HEADER
   13 FORMAT(2X,'HEADER CARD EXPECTED. FOLLOWING CARD INVALID'/2X,13A6)
      STOP 99

   15 HDCHK = '      '
      PRINT 16,HEADER
   16 FORMAT('1',27X,13A6//)
      BLKCNT = BLKCNT + (I + 1) * 9
      INVOWN = 0
      INVTEN = 0
      INVLOC = 0
      I = 0
      NOINBK = 0

   20 READ 10,DUMMY
      IF(HDCHK2.EQ.'*2    ') GO TO 70

C THE HEADER CARD FOR THE UCV-ICV INFORMATION CARDS MUST CONTAIN
C "*2    " IN THE FIRST 6 CHARACTER POSITIONS. THE NUMBER OF CARDS
C FOUND BETWEEN THE CARDS CONTAINING "*1    " & "*2    " IS THE
C NUMBER OF PROPERTIES IN THE BLOCK (I.E. I).

      I = I + 1
      DECODE(80,30,DUMMY,ITRANS,ERR=999) STCODE,STRTNO(I),STFRNT(I),
     1        SAREA(I),OWNER(I),LOC(I),TENURE(I)
   30 FORMAT(A2,1X,A6,1X,I3,1X,I6,1X,I1,2X,I1,1X,I1)

      IF(OWNER(I).GT.0) GO TO 45
      INVOWN = INVOWN + 1
      GO TO 50
   45 J  = OWNER(I)
```

```
      OWNCDE(J) = OWNCDE(J) + 1
   50 IF(LOC.GT.0) GO TO 55
      INVLOC = INVLOC + 1
      GO TO 60
 55   J = LOC(I)
      LOCDE(J) = LOCDE(J) + 1
   60 IF(TENURE.GT.0) GO TO 65
      INVTEN = INVTEN + 1
      GO TO 20
  65  J = TENURE(I)
      TENCDE(J) = TENCDE(J) + 1
      GO TO 20

           END OF GROUP OF HEADER CARDS
           NOW READ CARD TYPE 2

 70   CONTINUE


      IF(INVOWN.NE.0.OR.INVLOC.NE.0.OR.INVTEN.NE.0)
     X               PRINT 72,INVOWN,INVLOC,INVTEN
 72   FORMAT(2X,' NO. OF INVALID OWNERS CODES =',I2,5X,'NO. OF INVALID '
     1  'LOCATION CODES =',I2,5X,'NO. OF INVALID TENURE CARDS =',I2)

      DO 90 J = 1,I
      READ 80,ICODE,ISTNO,(UCV(K,J),ICV(K,J),K=1,3),AMAL(J)
 80    FORMAT(A2,1X,A6,1X,2(I7,1X,I7,7X),1X,I7,1X,I7,8X,I2)
        IF(ICODE.NE.STCODE) GO TO 85
        IF(ISTNO.NE.STRTNO(J)) GO TO 87
 90   CONTINUE
      GO TO 91

 85    PRINT 86,ICODE,STCODE
 86    FORMAT(' *** STREET CODES DO NOT AGREE. CARD CODE IS ',A2,
     F          ' HEADER CODE IS ',A2)
      STOP 44444
 87    PRINT 88,ISTNO,STRTNO(J)
 88   FORMAT('0  **** LOT NUMBERS DO NOT AGREE ****',2(3X,A6))
      STOP 55555

          READ 3RD CARD WHICH CONTAINS REST OF ICV AND UCV DATA
  ALL FURTHER HEADER CARDS ARE OF NO INTEREST.

 91   READ 10,DUMMY

       DO 100 J=1,I
      READ 95,ICODE,ISTNO,UCV(4,J),ICV(4,J)
 95   FORMAT(A2,1X,A6,1X,I7,1X,I7)
      IF(ICODE.NE.STCODE) GO TO 85
      IF(ISTNO.NE.STRTNO(J)) GO TO 87

 SAVE INFORMATION ON STREET CODE, LOT NUMBER, STREET FRONTAGE & ICV
 FOR USE IN LAND USE - RENT DISTANCE PROGRAM.
 THESE VALUES ARE WRITTEN ONTO THE FILE "VGOUTPUT".
 "RRRRRR" IS USED AS AN END-OF-BLOCK MARKER ON THIS FILE.

    WRITE(10,98) ICODE,ISTNO,STFRNT(J),(ICV(K,J),K = 1,4)
```

```
T WILSON VS PROGRAM

 99   FORMAT(A2,A6,I3,4I7)

100   CONTINUE

      ICODE = 'RRRRRR'
      WRITE(10,98) ICODE

      PRINT 110,(STRTNO(J),(UCV(K,J),K = 1,4),(ICV(K,J),K = 1,4),J =1,I)
110   FORMAT(///,25X,'UCV VALUES',46X,'ICV VALUES',//,2(16X,'1958',5X,
     1      '1962',5X,'1967',5X,'1972',9X),//,30(2X,A6,3X,4I9,20X,4I9,/))

          READ 4TH CARD

      READ 10,DUMMY

          PRINT  YEAR  OF  SALE  HEADING


      PRINT 16, HEADER
       PRINT 130
130   FORMAT('0',10X,'YEAR',5X,'STREET',3X,'ST. NO',3X,'SITE AREA',
     1  5X,'SALE VALUE',5X,'MOST RECENT UV',5X,'MOST RECENT IV',
     2  /11X,4('-'),5X,6('-'),3X,6('-'),3X,9('-'),5X,10('-'),5X,
     3  14('-'),5X,14('-'))

      ISUMSL = 0
      ISUMAR = 0

  READ IN SALE VALUES & YEARS OF SALE FOR ALL PROPERTIES IN THE BLOCK.

      DO 200 J=1,I

      READ 140,ICODE,ISTNO,(IYEAR(J,K),SVAL(K),K=1,3)
140   FORMAT(A2,1X,A6,3(1X,I2,1X,I7))

      IF(ICODE.NE.STCODE) GO TO 85
      IF(ISTNO.NE.STRTNO(J)) GO TO 87

      DO 200 K=1,3

      IYRSUB = IYEAR(J,K) - 57
      IF(IYRSUB.LT.1) GO TO 200

  DETERMINE WHICH WAS THE CLOSEST VALUATION YEAR.

      DO 160 UVSUB = 1,3
      IF(IYEAR(J,K).LT.SVALYR(UVSUB+1)) GO TO 180
160   CONTINUE

      UVSUB = 4

  DETERMINE IF HAVE IMPROVED PROP. OR NOT I.E. IS DIFFERENCE
  BETWEEN VALUES > $500
  PROPERTIES WITH ICV OR UCV INFO MISSING (I.E. = ZERO) ARE IGNORED.

180   IF(ICV(UVSUB,J).EQ.0.OR.UCV(UVSUB,J).EQ.0) GO TO 185
      IF(ABS(ICV(UVSUB,J) - UCV(UVSUB,J)).GE.501) GO TO 183
```

```
C     THIS SECTION FOR UNIMPROVED PROPERTIES.

      ISUMSL = ISUMSL + SVAL(K)
      ISUMAR = ISUMAR + SAREA(J)
      CTYSVU(IYRSUB) = CTYSVU(IYRSUB) +  SVAL(K)
      CTYSAU(IYRSUB) = CTYSAU(IYRSUB) + SAREA(J)
      CTYNPU(IYRSUB) = CTYNPU(IYRSUB) + 1
      GO TO 185

C     THIS SECTION FOR IMPROVED PROPERTIES.

  183 CTYSVI(IYRSUB) = CTYSVI(IYRSUB) +  SVAL(K)
      CTYSAI(IYRSUB) = CTYSAI(IYRSUB) + SAREA(J)
      CTYNPI(IYRSUB) = CTYNPI(IYRSUB) + 1

  185 IWARN = '      '

C     IF THE DIFFERENCE BETWEEN A SALE VALUE & AN UCV IN A VALUATION YEAR
C     > 20% OF THE UCV THEN PRINT A WARNING I.E. "******".

      DO 188 L = 1,4
      IF(IYEAR(J,K).NE.SVALYR(L)) GO TO 188
      RATIO = ABS ( SVAL (K) - UCV (UVSUB,J))
      RATIO = RATIO / FLOAT(UCV(UVSUB,J))
      IF(RATIO.GT.0.2) IWARN = '******'
      GO TO 189

  188 CONTINUE

  189 PRINT 190,IYEAR(J,K),ICODE,ISTNO,SAREA(J),SVAL(K),
     1     UCV(UVSUB,J),ICV(UVSUB,J),IWARN
  190 FORMAT(11X,'19',I2,7X,A2,5X,A6,4X,I6,3X,I7,9X,I7,12X,I7,9X,A6)

  200 CONTINUE

      IF(ISUMSL.EQ.0) GO TO 205
      TOTSLE = 1.0 * ISUMSL / ISUMAR
      PRINT 203, TOTSLE
  203 FORMAT(///,29X,'TOTAL UNIMPROVED PROPERTY SOLD AVERAGED $',
     1        F7.3,' PER SQ. FT.')

C          READ FLOOR SPACE DUMMY AND FLOOR SPACE DATA

  205  READ 10,DUMMY

       DO 220 J=1,I
       READ 210,ICODE,ISTNO,((FLRSP(K,L,J),L=1,6),K=1,2)
  210 FORMAT(A2,1X,A5,11(1X,I5),I5)
      IF(ICODE.NE.STCODE) GO TO 85
      IF(ISTNO.NE.STRTNO(J)) GO TO 87
  220 CONTINUE

      READ 10,DUMMY
      DO 240 J = 1,I
      READ 210,ICODE,ISTNO,((FLRSP(K,L,J),L=1,6),K=3,4)
```

```
      IF(ICODE.NE.STCODE) GO TO 85
      IF(ISTNO.NE.STRTNO(J)) GO TO 87
  240 CONTINUE

C CALCULATE TOTAL FLOOR SPACE FOR EACH BLOCK

      DO 245 K = 1,4
      DO 245 J = 1,I
  245 FLRSP(K,7,J) = 0

      DO 250 K = 1,4
      DO 250 J = 1,I
      DO 250 L = 1,6
  250 FLRSP(K,7,J) = FLRSP(K,7,J) + FLRSP(K,L,J)

C PRINT OUT FLOOR SPACE TABLE

      PRINT 10, HEADER
      PRINT 260
  260 FORMAT('0',50X,'FLOOR SPACE TABLE',//,39X,'1958',
     1       56X,'1962',/,12X,2('B. MENT GROUND  FIRST   SECOND  THIRD',
     2       3X,'O UPPER TOTAL',7X))

      DO 280 J = 1,I
      PRINT 270, STRTNO(J),((FLRSP(K,L,J),L = 1,7),K = 1,2)
  270 FORMAT(2X,A6,2(7I8,5X))
  280 CONTINUE

C ZEROISE ARRAYS.

      DO 290 K = 1,4

      IRSUM(K) = 0
      IRSSQ(K) = 0
      NOIRET(K) = 0

      DO 290 L = 1,7

      IRENT(K,L) = 0
      PCSUM(K,L) = 0
      PSUMSQ(K,L) = 0
      NORENT(K,L) = 0
  290 TOTFLR(K,L) = 0

      DO 320 K = 1,4
      DO 320 L = 1,7

      DO 320 J = 1,I
      TOTFLR(K,L) = TOTFLR(K,L) + FLRSP(K,L,J)

      DO 320 M = 1,3

      IYRSUB = IYEAR(J,M) - 57
      IF(IYRSUB.LT.1) GO TO 320

      DO 300 UVSUB = 1,3
```

AT WILSON VG PROGRAM

```
      IF(IYEAR(J,M).LT.SVALYR(UVSUB+1)) GO TO 310
  300 CONTINUE
      UVSUB = 4
  310 IF(ICV(UVSUB,J).EQ.0.OR.UCV(UVSUB,J).EQ.0) GO TO 320
C FIND TOTAL FLOOR SPACE FOR IMPROVED LOTS.
      IF(ABS(ICV(UVSUB,J) - UCV(UVSUB,J)).GE.501)
     X               CTYSFL(IYRSUB) = CTYSFL(IYRSUB) + FLRSP(K,7,J)
  320 CONTINUE
      PRINT 330, ((TOTFLR(K,L),L = 1,7),K = 1,2)
  330 FORMAT(/,2X,'TOTAL ',7I8,5X,7I8)
      PRINT 340
  340 FORMAT(//,39X,'1967',56X,'1972',/,12X,
     1    2('B. MENT GROUND  FIRST   SECOND  THIRD    & UPPER TOTAL',7X))
      DO 350 J = 1,I
      PRINT 270,  STRTNO(J),((FLRSP(K,L,J),L = 1,7),K = 3,4)
  350 CONTINUE
      PRINT 330,((TOTFLR(K,L),L = 1,7),K = 3,4)
C
C   CALCULATE II AND THI FOR EACH LOT
C  II  = TOTAL FLOOR SPACE / SITE AREA
C  THI = TOTAL FLOOR SPACE / GROUND FLOOR AREA
      PRINT 16, HEADER
      PRINT 352
  352 FORMAT('0',17X,'1 9 5 8',23X,'1 9 6 2',23X,'1 9 6 7',23X,
     1    '1 9 7 2',//,11X,4(2X,'II',13X,'THI',10X))
      DO 370 J = 1,I
      DO 355 K = 1,4
      FLR = FLRSP(K,7,J)
      II(K) = FLR / SAREA(J)
  355 THI(K) = FLR / FLRSP(K,2,J)
      PRINT 360, STRTNO(J),((II(K),THI(K)),K = 1,4)
  360 FORMAT(1X,A6,2X,4(F6.2,10X,F6.2,8X))
  370 CONTINUE
C CALCULATE TOTAL SITE AREA IN BLOCK
      ISAREA = 0
      DO 380 J = 1,I
  380 ISAREA = ISAREA + SAREA(J)
```

```
      PRINT 390
  390 FORMAT(///,36X,'BLOCK II',23X,'BLOCK THI',/,
     1       29X,2('1958  1962  1967  1972   ',8X),/)
C
C     CALCULATE THI (TOTAL HEIGHT INDEX) & II FOR COMPLETE BLOCK.
C
      DO 400 K = 1,4
      FL = TOTFLR(K,7)
      II(K) = FL / ISAREA
  400 THI(K) = FL / TOTFLR(K,2)

      PRINT 410, II,THI
  410 FORMAT(27X,4F6.2,8X,4F6.2)

C
C     READ RENT CARDS
C
      READ 10,DUMMY

      DO 430  J = 1,I
      READ 420, ICODE,ISTNO,((RENT(K,L,J),L = 1,6),K = 1,2),
     1           (RENT(3,M,J),M=1,2)
  420 FORMAT(A2,1X,A6,14(1X,I4))

      IF(ICODE.NE.STCODE) GO TO 85
      IF(ISTNO.NE.STRTNO(J)) GO TO 87

  430 CONTINUE

      READ 10, DUMMY

      DO 450 J = 1,I
      READ 440,ICODE,ISTNO,(RENT(3,L,J),L = 3,6),
     1           (RENT(4,L,J),L=1,6)
  440 FORMAT(A2,1X,A6,10(1X,I4))

      IF(ICODE.NE.STCODE) GO TO 85
      IF(ISTNO.NE.STRTNO(J)) GO TO 87

  450 CONTINUE

C     CONVERT RENT / SQUARE FOOT TO TOTAL RENT

      DO 460 K = 1,4
      DO 460 J = 1,I
  460 RENT(K,7,J) = 0

      DO 470 J = 1,I
      DO 470 K = 1,4
      DO 470 L = 1,6
      RENT(K,L,J) = RENT(K,L,J) * FLRSP(K,L,J)
  470 RENT(K,7,J) = RENT(K,7,J) + RENT(K,L,J)

      PRINT 16,HEADER

      PRINT 480
  480 FORMAT('0',50X,'RENT TABLE'/,34X,'1958',58X,'1962',
```

```
    1         //,10X,2('B. MENT GROUND  FIRST   SECOND  THIRD   ',
    2         'O UPPER    TOTAL',5X)/)

C PRINT RENT TABLES./

      DO 510 J = 1,I
      PRINT 500, STRTNO(J),((RENT(K,L,J),L = 1,7),K = 1,2)
  500 FORMAT(1X,A6,2(6I8,I10,2X))
  510 CONTINUE

      DO 520 K = 1,4
      DO 520 L = 1,7
      DO 520 J = 1,I
      IRNT = RENT(K,L,J)
      TRENT(K,L) = TRENT(K,L) + IRNT
      IF(IRNT.NE.0) NORENT(K,L) = NORENT(K,L) + 1
  520 CONTINUE

      PRINT 530, ((TRENT(K,L),L = 1,7),K = 1,2)
  530 FORMAT('0TOTAL',1X,2(6I8,I10,2X))

      PRINT 540
  540 FORMAT(//,34X,'1967',58X,'1972',//,10X,
    1         2('B. MENT GROUND  FIRST   SECOND  THIRD    O UPPER    TOTAL',
    2         5X),//)

      DO 550 J = 1,I
  550  PRINT 500, STRTNO(J),((RENT(K,L,J),L=1,7),K=3,4)

      PRINT 530, ((TRENT(K,L),L = 1,7),K = 3,4)

      DO 650 IX = 1,2

      IF(IX.NE.1) GO TO 565

      I1 = 1
      I2 = 2

      PRINT 16,HEADER

      PRINT 560
  560 FORMAT('0',    31X,'1958',62X,'1962',//,13X,'CRI',23X,'RENT',
    1   ' RETURNS',24X,'CRI',23X,'RENT RETURNS',/,21X,'RET 1',6X,'B',6X,
    2    'G',6X,'1',6X,'2',6X,'3',6X,'O',15X,'RET 1',6X,'B',6X,'G',6X,
    3    '1',6X,'2',6X,'3',6X,'O')

      GO TO 568
  565 I1 = 3
      I2 = 4

C RET 1 (I.E. IRET) = TOTAL RENT FOR A PROPERTY / ICV OF THE PROPERTY.
C PCRETS ARE THE PERCENTAGES CONTRIBUTED BY EACH FLOOR TO THIS RETURN
C VALUE IRET.
C CRI = TOTAL RENT FOR PROPERTY / TOTAL FLOOR SPACE

  568 DO 590 J = 1,I
```

PAT WILSON VS PROGRAM

```
      DO 575 K = I1,I2

      RT = RENT(K,7,J)
      IF(RT.EQ.0.0) GO TO 575
      CRI(K) = RT / FLRSP(K,7,J) + 0.49
      IF(ICV(K,J).EQ.0) GO TO 569

C STORE VALUES TO DETERMINE IRET & ITS MEAN & STANDARD DEVIATION.

      IRET(K) = RT / ICV(K,J)
      NOIRET(K) = NOIRET(K) + 1
      IRSUM(K) = IRSUM(K) + IRET(K)
      IRSSQ(K) = IRSSQ(K) + IRET(K) * IRET(K)

C STORE VALUES TO DETERMINE PCRET (THE PERCENT RETURNS) & ITS MEAN
C & STANDARD DEVIATION.

  569 DO 570 L = 1,6

      PCRET(K,L) = RENT(K,L,J) * 100.0 / RT
      PCSUM(K,L) = PCSUM(K,L) + PCRET(K,L)
      PSUMSQ(K,L) = PSUMSQ(K,L) + PCRET(K,L) * PCRET(K,L)

  570 CONTINUE

  575 CONTINUE

      PRINT 580, STRTNO(J),((CRI(K),IRET(K),(PCRET(K,L),L = 1,6),
     1                                                   K = I1,I2))
  580 FORMAT(1X,A6,2(I9,F10.2,6F7.2,1X))

  590 CONTINUE

C CALCULATE MEANS AND STD. DEV.

      DO 600 K = I1,I2

      IF(NOIRET(K).LE.1) GO TO 595
      IRSSQ(K) = ( IRSSQ(K) - ((IRSUM(K) * IRSUM(K)) / NORENT(K,7))) /
     1                                                 (NOIRET(K) - 1)
      IRSSQ(K) = SQRT(IRSSQ(K))
      IRSUM(K) = IRSUM(K) / NOIRET(K)
      GO TO 600

  595 IRSSQ(K) = 0
      IF(NOIRET(K).EQ.0) IRSUM(K) = 0

  600 CONTINUE


      DO 620 K = I1,I2
      DO 620 L = 1,6

      IF(NORENT(K,L).LE.1) GO TO 610

      PSUMSQ(K,L) = (PSUMSQ(K,L) - ((PCSUM(K,L) * PCSUM(K,L)) /
     1                         NORENT(K,L)) ) / (NORENT(K,L) - 1)
```

```
      PCSUM(K,L) = PCSUM(K,L) / NORENT(K,L)
      PSUMSQ(K,L) = SQRT(PSUMSQ(K,L))
      GO TO 620

 610  PSUMSQ(K,L) = 0
      IF(NORENT(K,L).EQ.0) PCSUM(K,L) = 0

 620  CONTINUE

      PRINT 630, (IRSUM(K),(PCSUM(K,L),L = 1,6),K = I1,I2)
 630  FORMAT('0MEAN',1X,2(13X,7F7.2))

      PRINT 635, (IRSSQ(K),(PSUMSQ(K,L),L = 1,6),K = I1,I2)
 635  FORMAT(' STD. DEV.',9X,7F7.2,13X,7F7.2)

      IF(IX.NE.1) GO TO 650

      PRINT 640
 640  FORMAT(//,31X,'1967',62X,'1972',//,13X,'CRI',23X,'RENT',
     1  ' RETURNS',24X,'CRI',23X,'RENT RETURNS',/,7X,
     2   2(14X,'RET 1',6X,'B',6X,'G',6X,'1 ',6X,'2',6X,'3 ',6X,'0 '))

 650  CONTINUE

      DO 653 K = 1,4
 653  CRI(K) = FLOAT(TRENT(K,7)) / FLOAT(TOTFLR(K,7)) + 0.49

      PRINT 657, CRI
 657  FORMAT(////,57X,'TOTAL CRI FOR BLOCK',/,
     1        52X,'1958    1962    1967    1972',//,48X,4I8)

   WRITE ALL CRI II & THI ONTO TEMPORY FILE FOR BLOCK REPORT AT END.

      WRITE (20,658) (HEADER(K),K = 2,10),CRI,II,THI
 658  FORMAT(2X,9A6,5X,4I5,2(5X,4F5.2))

  READ OS AND T HEADER CARD

      READ 10,DUMMY

      PRINT 759
 759  FORMAT('0',45X,'OWNER/LOCATION/TENURE INFO.',/,
     X        '0  NUMBER     OO LO TO *O *L *T YOS  O1  L1  T1',
     X        '  YOS  O2  L2  T2  YOS  O3  L3  T3  YOS  O4  ',
     X        'L4  T4  YOS  O5  L5  T5',//)

  ZEROISE BLOCK OWNER - ICV INFO ARRAYS.

      DO 659 INDOWN = 1,6
      DO 659 K = 1,4
      BLKICV(K,INDOWN) = 0
 659  BLK OSA(K,INDOWN) = 0

      DO 700 J = 1,I
      READ 660,ICODE,ISTNO,ORIGTC,ORIGLC,ORIGTN,
     1     (YOS(K),OWN(K),LOCN(K),TEN(K),K=1,5)
```

PAT WILSON VG PROGRAM

```
 660 FORMAT(A2,1X,A6,1X,I1,2X,2(I1,1X),5(I2,1X,I1,
    12X,I1,1X,I1,1X))
     IF(ICODE.NE.STCODE) GO TO 85
     IF(ISTNO.NE.STRTNO(J)) GO TO 87
     LST = 15
     IST = 1
     IF(ORIGTC.EQ.0) GO TO 663
     IKEY = ORIGTC * 100 + ORIGLC * 10 + ORIGTN
     GO TO 664
663  IKEY = OWNER(J) * 100 + LOC(J) * 10 + TENURE(J)
664  IF(IKEY.EQ.0) IKEY = 1

  CROSS-TABULATION IS CONSTRUCTED AS A VECTOR OF 700 FOR EACH YEAR
  1358 - 1972. THE POSITION IN THIS ARRAY IS DETERMINED BY -
            100 * OWNER CODE +
             10 * LOCATION CODE +
                  TENURE CODE.
  SO EACH ELEMENT GIVES A UNIQUE COMBINATION OF OWNER-LOCATION-TENNANT.

     DO 680 K=1,5
     IF(YOS(K).EQ.0) GO TO 665
     IF(YOS(K).LT.59) GO TO 675
     LST = YOS(K) - 58
     IF(LST.GT.15) LST = 15

 665 DO 670 N=IST,LST
 670 CTAB(N,IKEY) = CTAB(N,IKEY) + 1
     CTAB(16,IKEY) = 1
     IF(LST.EQ.15) GO TO 674
     IST = LST + 1
     LST = 15
675  IKEY = OWN(K) * 100 + LOCN(K) * 10 + TEN(K)
     IF(IKEY.EQ.0) IKEY = 1
 680 CONTINUE

  DETERMINE OWNER CODE FOR EACH VALUATION YEAR & THEN ACCUMALATE ALL
  ICV'S & SITE AREA'S.

674  INDOWN = ORIGTC
     IF(INDOWN.EQ.0) INDOWN = OWNER(J)

     DO 679 K = 1,4

     DO 676 L = 1,5
     IF(YOS(L).EQ.0) GO TO 678
     IF(SVALYR(K).LT.YOS(L)) GO TO 677
676  CONTINUE

     INDOWN = OWN(5)
     GO TO 678

677  IF(L.GT.1) INDOWN = OWN(L-1)

678  IF(INDOWN.EQ.0) GO TO 679
     TOTICV(K,INDOWN) = TOTICV(K,INDOWN) + ICV(K,J)
     BLKICV(K,INDOWN) = BLKICV(K,INDOWN) + ICV(K,J)
     TOTOSA(K,INDOWN) = TOTOSA(K,INDOWN) + SAREA(J)
```

```
1     BLKOSA(K,INDOWN) = BLKOSA(K,INDOWN) + SAREA(J)

679   CONTINUE

      PRINT 690,ISTNO,ORIGIC,ORIGLC,ORIGIN,OWNER(J),LOC(J),TENURE(J),
    X            (YOS(K),OWN(K),LOCN(K),TEN(K),K = 1,5)
690   FORMAT(2X,A6,3X,6I3,5(I5,3I4))
 700  CONTINUE

      ICC = 0

      PRINT 16,HEADER

      PRINT 4080,ICC,SVALYR

   PRINT OUT BLOCK OWNER - ICV INFO.

       DO 704 I = 1,6

      PRINT 4090,I,(BLKICV(J,I),J = 1,4)

      PRINT 5000,(BLKOSA(J,I), J = 1,4)

      DO 702 J = 1,4
702   BLKICV(J,I) = BLKICV(J,I) / BLKOSA(J,I)

      PRINT 5010,(BLKICV(J,I), J = 1,4)

704   CONTINUE


    GO BACK AND READ IN NEXT BLOCK OF VG DATA

      GO TO 1

       PRINT  CROSS  TABULATION

705   PRINT 710,(I,I = 58,72)
710   FORMAT(1H1,50X,'CROSSTABULATIONS'//'OWN LOC TEN',I6,
   1      14I3,//)

      DO 740 K = 1,730
      IF(CTAB(16,K).EQ.0) GO TO 740
      I1 = K / 100
      I3 = K - I1 * 100
      I2 = I3 / 10
      I3 = I3 - I2 * 10
      PRINT 720, I1,I2,I3,(CTAB(I,K),I = 1,15)
720   FORMAT(3I4,15(I6,2X),/)
740   CONTINUE

      END FILE 20
      END FILE 10
      REWIND 20
      PRINT 750
750   FORMAT('1',40X,'SUMMARY OF ALL BLOCK "II"S "THI"S & "CRI"S.',
   X        /,70X,'CRI',22X,'II',23X,'THI',///)
```

T WILSON VG PROGRAM

```
760   READ(20,770,END=800) (SAREA(J),J = 1,22)
770   FORMAT(21A6,A5)
      PRINT 770,(SAREA(J),J = 1,22)
      GO TO 760

  NOW CALCULATE UNIMPROVED (& IMPROVED) SALE VALUES FOR THE ENTIRE
  CITY PER 1. SQUARE FOOT OF SITE AREA
             2. NO. OF PROPERTIES
             3. SQUARE FOOT OF FLOOR AREA (OBVIOUSLY FOR IMPROV. PROP.)

  EACH OF THE ABOVE ARE CALCULATED FOR THE YEARS OF SALE , HOWEVER AS
  THE CRITERION DISTINGUISHING UNIMPR. FROM IMPR. PROPERTIES IS BASED
  ON VALUATION YEARS DATA THE NON-VALUATION YEARS RESULTS SHOULD BE
  TAKEN WITH A DOSE OF SALT.

800   I1 = 58
      I2 = 65
      ICC = 1

805   PRINT 4000,ICC,(I,I = I1,I2)
000   FORMAT(I1,70X,'YEAR OF SALE',/,27X,8I13)

      I3 = I1 - 57
      I4 = I2 - 57

      PRINT 4010,(CTYSVU(I),I = I3,I4)
01C   FORMAT('0      SALE VALUES',/,'   TOTAL UNIMPROVED ',7X,8F13.0)

      DO 810 I = I3,I4
      IF(CTYSAU(I).EQ.0.0) GO TO 810
      CTYSAU(I) = CTYSVU(I) / CTYSAU(I)
810   CONTINUE

      PRINT 4020,(CTYSAU(I),I = I3,I4)
020   FORMAT('0 UNIMPR./SQ. FT. SITE AREA',8F13.2)

      PRINT 4030,(CTYNPU(I),I = I3,I4)
1030  FORMAT('0 NO. UNIMPR. PROP. SOLD    ',8I13)

      PRINT 4040,(CTYSVI(I),I = I3,I4)
040   FORMAT('0      SALE VALUES',/,'  TOTAL IMPROVED',11X,8F13.0)

      DO 830 I = I3,I4
      IF(CTYSAI(I).EQ.0.0) GO TO 830
      CTYSAI(I) = CTYSVI(I) / CTYSAI(I)
830   CONTINUE

      PRINT 4050,(CTYSAI(I),I = I3,I4)
C50   FORMAT('0IMPROVED/SQ.FT. SITE AREA ',8F13.2)

      DO 840 I = I3,I4
      IF(CTYSFL(I).EQ.0.0) GO TO 840
      CTYSFL(I) = CTYSVI(I) / CTYSFL(I)
840   CONTINUE

      PRINT 4060,(CTYSFL(I),I = I3,I4)
```

WILSON VG PROGRAM

```
 4060  FORMAT('CIMPROVED/SQ.FT. FLR. AREA ',8F13.2)

       PRINT 4070,(CTYNPI(I),I = I3,I4)
 4070  FORMAT('0 NO. IMPROVED PROP. SOLD  ', 8I13,/)

       IF(I1.EQ.56) GO TO 900
       I1 = 66
       I2 = 72
       ICC = 0
       GO TO 805

C   NOW PRINT THE ICV / SITE AREA RATIO FOR ALL OWNER CODES.

  900  ICC = 1
       PRINT 4080,ICC,SVALYR
 4080  FORMAT(I1,55X,'VALUATION YEARS',/,42X,4('19',I2,13X),//)

       DO 920 I = 1,6

       PRINT 4090,I,(TOTICV(J,I),J = 1,4)
 4090  FORMAT('0  TOTAL ICV FOR OWNER CODE',I2,1X,4(9X,F8.0))

       PRINT 5000,(TOTOSA(J,I),J = 1,4)
 5000  FORMAT('    TOTAL SITE AREA (SQ.FT.)',3X,4(9X,F8.0))

       DO 910 J = 1,4
  910  TOTICV(J,I) = TOTICV(J,I) / TOTOSA(J,I)

       PRINT 5010,(TOTICV(J,I),J = 1,4)
 5010  FORMAT('    PROPERTY VALUE / SQ.FT. ',3X,4(9X,F8.2))

  920  CONTINUE

       PRINT 8080
 8080  FORMAT('1    SUCCESSFUL RUN')
  999  STOP 999
       END
```

APPENDIX I

ALTERATION TO STANDARD IBM 1620 PACKAGE TO INCLUDE CALCULATION OF SKEW

```
C     SINGLE AND MULTIPLE LINEAR REGRESSION ANALYSIS.
C
      DIMENSION A%10,10<,C%10<,SUMX%10<,SUMXY%10<,W%10<,XX%10,100<
      PRINT 100
C
C     PROGRAM INITIALIZATION.
C
 1    READ  110,%C%I<,I#1,10<,%W%J<,J#1,4<
      PRINT 121
      PRINT 110,%C%I<,I#1,10<,%W%J<,J#1,4<
      READ,EK,EN
      K#EK
      N#EN
      PRINT 102,K
      PRINT 103,N
      SUMY#0.0
      SUMYS#0.0
      DO 2 L#1,K
      SUMX%L<#0.0
      SUMXY%L<#0.0
      XX%L,1<#0.0
      DO 2 J#L,K
    2 A%L,J<#0.0
C
C     SUMMATION OF X%L<, X%L<*Y, AND X%L<*X%J<.
C
      DO 3 I#1,N
      READ,Y
      READ,%W%M<,M#1,K<
C
C     SUMMATION OF Y AND Y SQUARED.
C
      SUMY#SUMY&Y
      SUMYS#SUMYS&Y*Y
      DO 3 L#1,K
      SUMX%L<#SUMX%L<&W%L<
      SUMXY%L<#SUMXY%L<&W%L<*Y
      DO 30 J#L,K
 30   A%L,J<#A%L,J<&W%L<*W%J<
 60   DO 33 J#1,I
      JJ#I-J&1
      IF%W%L<-XX%L,JJ<< 33,32,32
 32   XX%L,JJ&1<#W%L<
      GO TO 3
 33   XX%L,JJ&1<#XX%L,JJ<
      XX%L,1<#W%L<
 3    CONTINUE
C
C     COMPUTATION OF THE CONSTANT VECTOR C%L<.
C     COMPUTATION OF THE COEFFICIENT MATRIX FOR THE NORMAL EQUATIONS.
C
C     Y-X DATA READ IN.
C
C
      DO 4 L#1,K
```

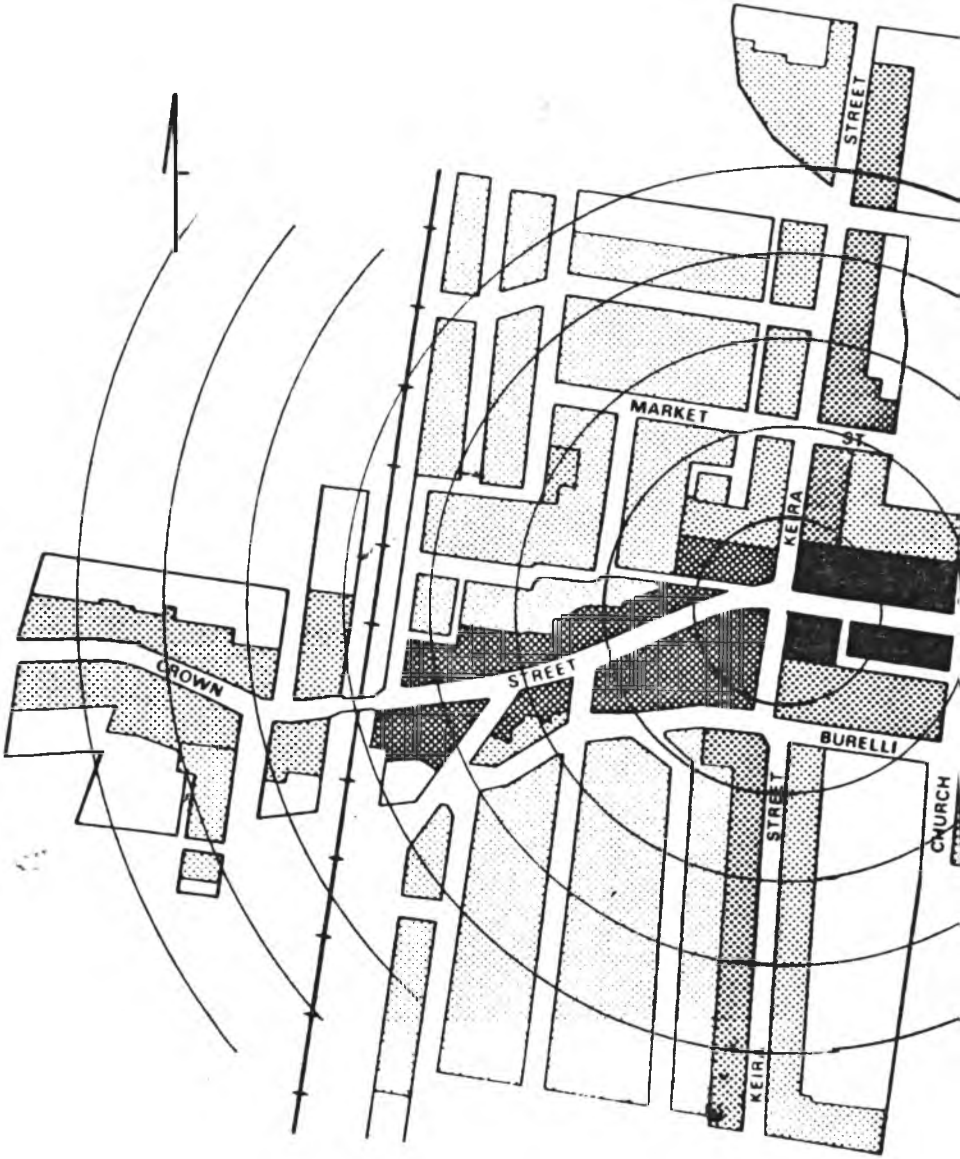
```
      C%L<#EN*SUMXY%L<-SUMX%L<*SUMY
      DO 4 J#L,K
      A%L,J<#EN*A%L,J<-SUMX%L<*SUMX%J<
    4 A%J,L<#A%L,J<
      CY#EN*SUMYS-SUMY*SUMY
C
C     COMPUTATION OF CORRELATION COEFFICIENTS Y TO X%L<
C
      PRINT 118
      PRINT 119
      DO 20 L#1,K
      R#C%L</SQRTF%CY*A%L,L<<
   20 PRINT 120,L,R
      PRINT 121
C
C     COMPUTATION OF THE PARTIAL CORRELATION COEFFICIENTS X%L< TO X%J<.
C
   40 PRINT 104
      PRINT 105
      DO 5 L#1,K
      DO 5 J#L,K
      R#A%L,J</SQRT%A%L,L<*A%J,J<<
    5 PRINT 106,L,J,R
C
C     COMPUTATION OF MEAN,VARIANCE,MEDIAN AND SKEWNESS
C
      PRINT 121
      PRINT 1102
      DO 39 I#1,K
      XMEAN#SUMX%I</EN
      XVAR#SQRTF%A%I,I</EN/EN<
      IF%N-2*%N/2<< 36,36,37
   36 J#N/2&1
      XMED#%XX%I,J<&XX%I,J&1<</2.
      GO TO 38
   37 J#N/2&2
      XMED#XX%I,J<
   38 XSKEW#3.*%XMEAN-XMED</XVAR
   39 PRINT1103,I,XMEAN,XVAR,XMED,XSKEW
      PRINT 121
C
C     MATRIX INVERSION BY ROLLING METHOD.
C     INVERSE REPLACES ORIGINAL A MATRIX.
C
   50 K1#K-1
      IF %K1< 1,6,7
    6 A%1,1<#1.0/A%1,1<
      GO TO 12
    7 DO 11 ITER#1,K
      W%K<#1.0/A%1,1<
      DO 8 J#1,K1
    8 W%J<#A%1,J&1<*W%K<
      DO 10 L#1,K1
      DO 9 J#1,K1
    9 A%L,J<#A%L&1,J&1<-A%L&1,1<*W%J<
   10 A%L,K<#-A%L&1,1<*W%K<
      DO 11 J#1,K
```

```
   11 A%K,J<#W%J<
C
C     COMPUTATION OF THE PARTIAL REGRESSION COEFFICIENTS.
C
   12 SUM#0.0
      BZERO#SUMY/EN
      DO 14 J#1,K
      W%J<#0.0
      DO 13 L#1,K
   13 W%J<#W%J<&C%L<*A%L,J<
      SUM#SUM&W%J<*C%J<
   14 BZERO#BZERO-W%J<*SUMX%J</EN
      PRINT 107
      PRINT 108
      J#0
      PRINT 109,J,BZERO
      DO 15 J#1,K
   15 PRINT 109,J,W%J<
C
C     COMPUTATION OF THE MULTIPLE CORRELATION COEFFICIENT.
C     COMPUTATION OF THE STANDARD ERROR OF THE Y DATA.
C     COMPUTATION OF THE STANDARD ERROR OF THE ESTIMATE.
C     COMPUTATION OF THE SIGNIFICANCE OF REGRESSION %F<.
C
      AYY#EN*SUMYS-SUMY*SUMY
      RMULT#SUM/AYY
      SY#AYY/%EN*%EN-1.0<<
      SYX#SY*%EN-1.0<*%1.0-RMULT</%EN-EK-1.0<
      F#SUM/%EN*EK*SYX<
      RMULT#SQRT%RMULT<
      SY#SQRT%SY<
      SYX#SQRT%SYX<
      PRINT 110,RMULT
      PRINT 111,SY
      PRINT 112,SYX
      PRINT 113,F
C
C     COMPUTATION OF THE STANDARD ERROR OF
C     THE PARTIAL REGRESSION COEFFICIENTS.
C
      PRINT 114
      PRINT 115
      SB#1.0
      DO 16 L#1,K
      DO 16 J#1,K
   16 SB#SB&A%L,J<*SUMX%L<*SUMX%J<
      SB#SYX*SQRT%SB/EN<
      J#0
      PRINT 109,J,SB
      DO 17 J#1,K
      SB#SYX*SQRT%EN*A%J,J<<
   17 PRINT 109,J,SB
      GO TO 1
C
C     FORMAT STATEMENTS
C
  100 FORMAT %//47H SINGLE AND MULTIPLE LINEAR REGRESSION ANALYSIS<
```

```
101 FORMAT %F7.0,F7.0,F7.0,F7.0,F7.0,F7.0,F7.0,F7.0,F7.0,F7.0<
102 FORMAT %///34H NUMBER OF INDEPENDENT VARIABLES # I4/<
103 FORMAT %34H NUMBER OF DATA POINTS                # I4//<
104 FORMAT %45H PARTIAL CORRELATION COEFFICIENTS X%L< TO X%J</<
105 FORMAT %8X 2H L,8X 2H J,10X 7H R%L,J</<
106 FORMAT %I10,I10,E20.8<
107 FORMAT %//32H PARTIAL REGRESSION COEFFICIENTS/<
108 FORMAT %18X 2H J,11X 5H B%J</<
109 FORMAT %10X I10,E20.8<
110 FORMAT %//35H MULTIPLE CORRELATION COEFFICIENT # E20.8/<
111 FORMAT %35H STANDARD ERROR OF THE Y DATA      # E20.8/<
112 FORMAT %35H STANDARD ERROR OF THE ESTIMATE    # E20.8/<
113 FORMAT %35H SIGNIFICANCE OF REGRESSION %F<    # E20.8///<
114 FORMAT %26H STANDARD ERROR OF PARTIAL,24H REGRESSION COEFFICIENTS<
115 FORMAT %/18X 2H J,10X 6H SB%J</<
118 FORMAT%35H CORRELATION COEFFICIENTS Y TO X%L</<
119 FORMAT%18X 2H L,10X7H R%Y,L</<
120 FORMAT%10X,I10,E20.8<
116 FORMAT%14A5<
121 FORMAT%//<
1102 FORMAT%11X4HMEAN,11X8HVARIANCE,10X6HMEDIAN,10X8HSKEWNESS<
1103 FORMAT%I4,4%2XE15.8<<
    END
                                                    05,04,05 <2-K%FI
                                                     3,06,3 <2-K%FI
```

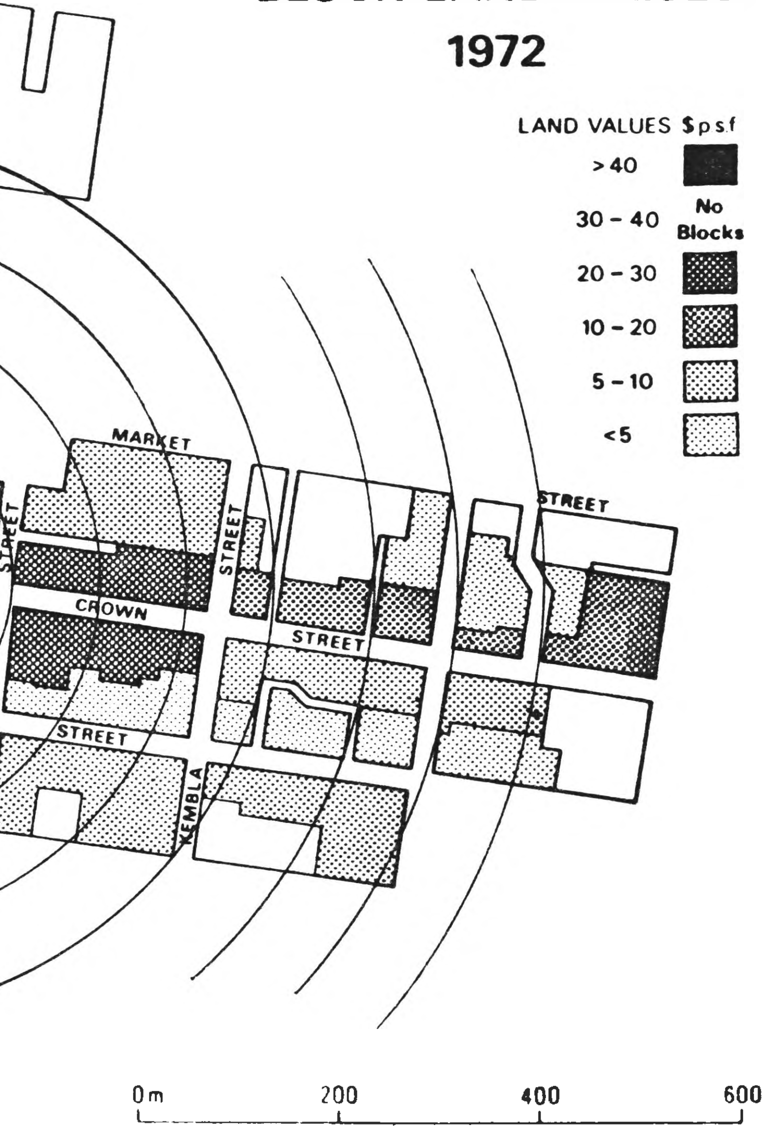
MAPS

Map 1



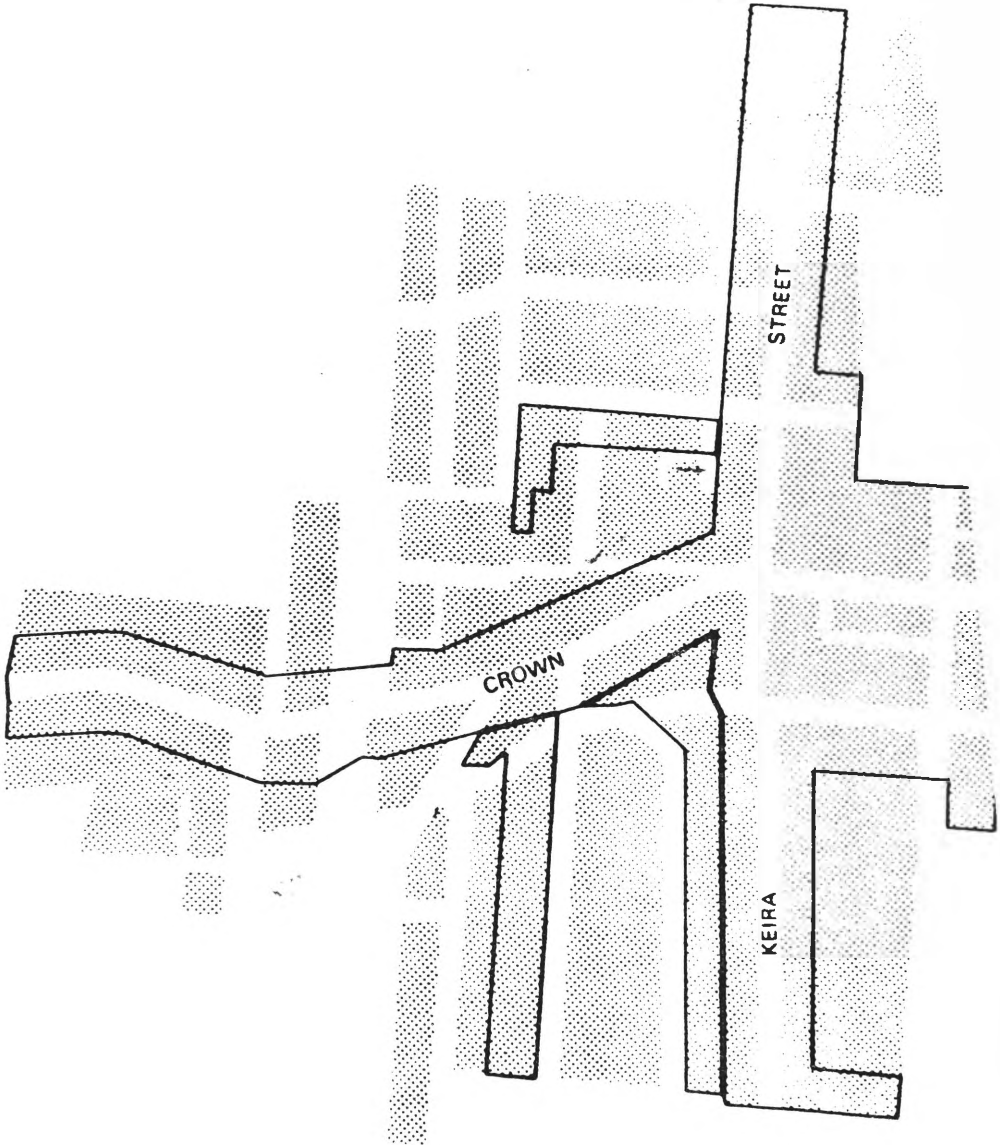
Drawn by R.A.Miller, Cartographic Unit, Department of Geography, Wollongong University: from data supplied by P.J.Wilson for 'Urban Illawarra', edited by Dr R Robinson.

BLOCK LAND VALUES
1972

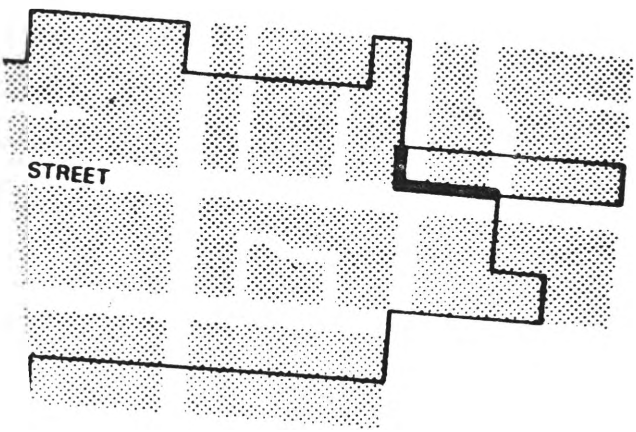


Map 2

A



5%
LAND VALUE INDEX BOUNDARIES



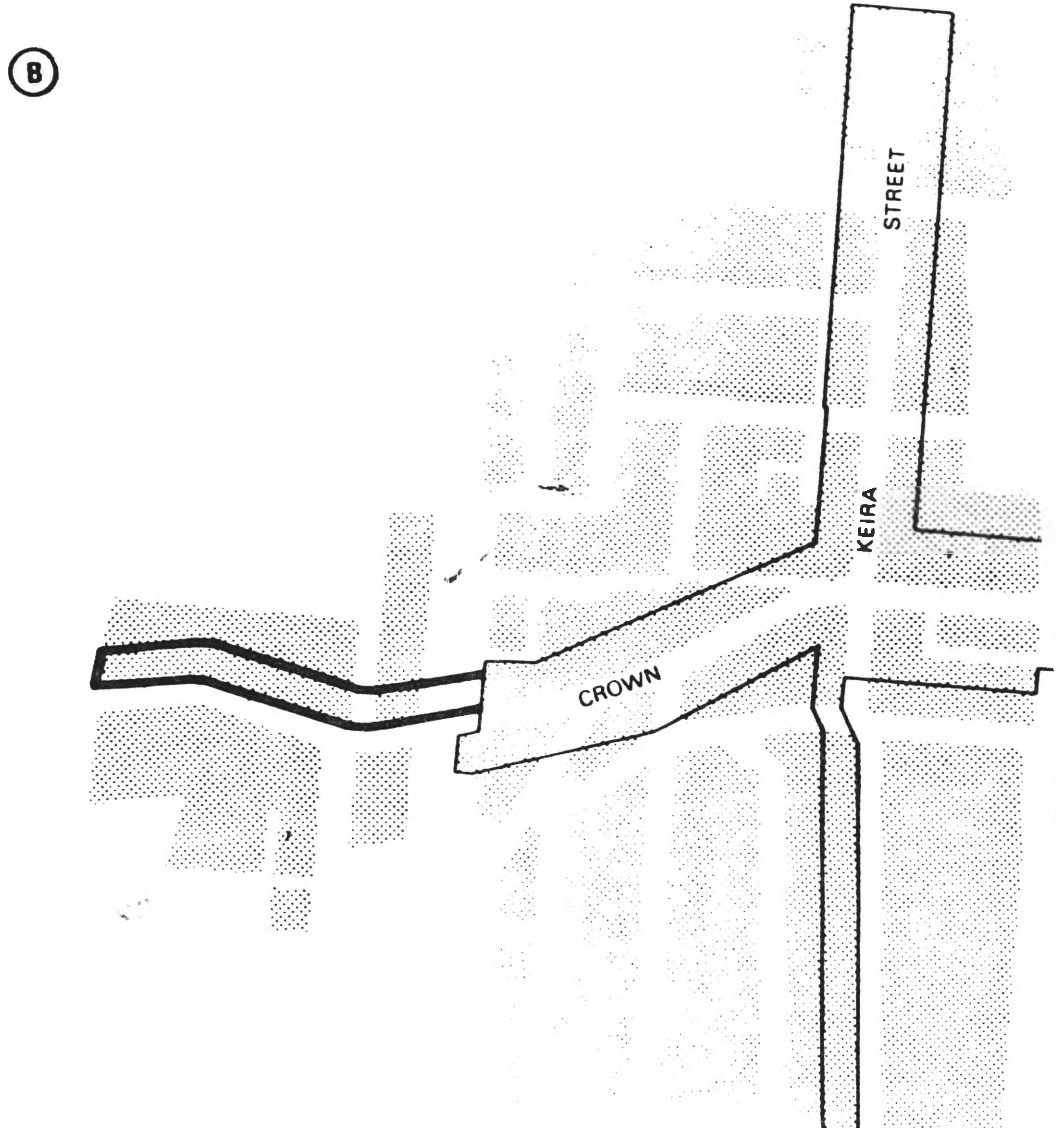
1972 —

1967 as for 1972 except where shown —

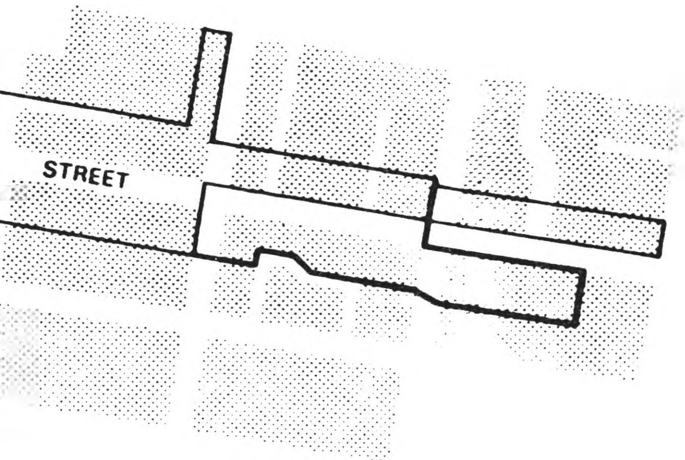
1962 as for 1967

1958 as for 1962 except where shown ▬

Map 3



12%
LAND VALUE INDEX BOUNDARIES



1972 ——

1967 as for 1972 except where shown ——

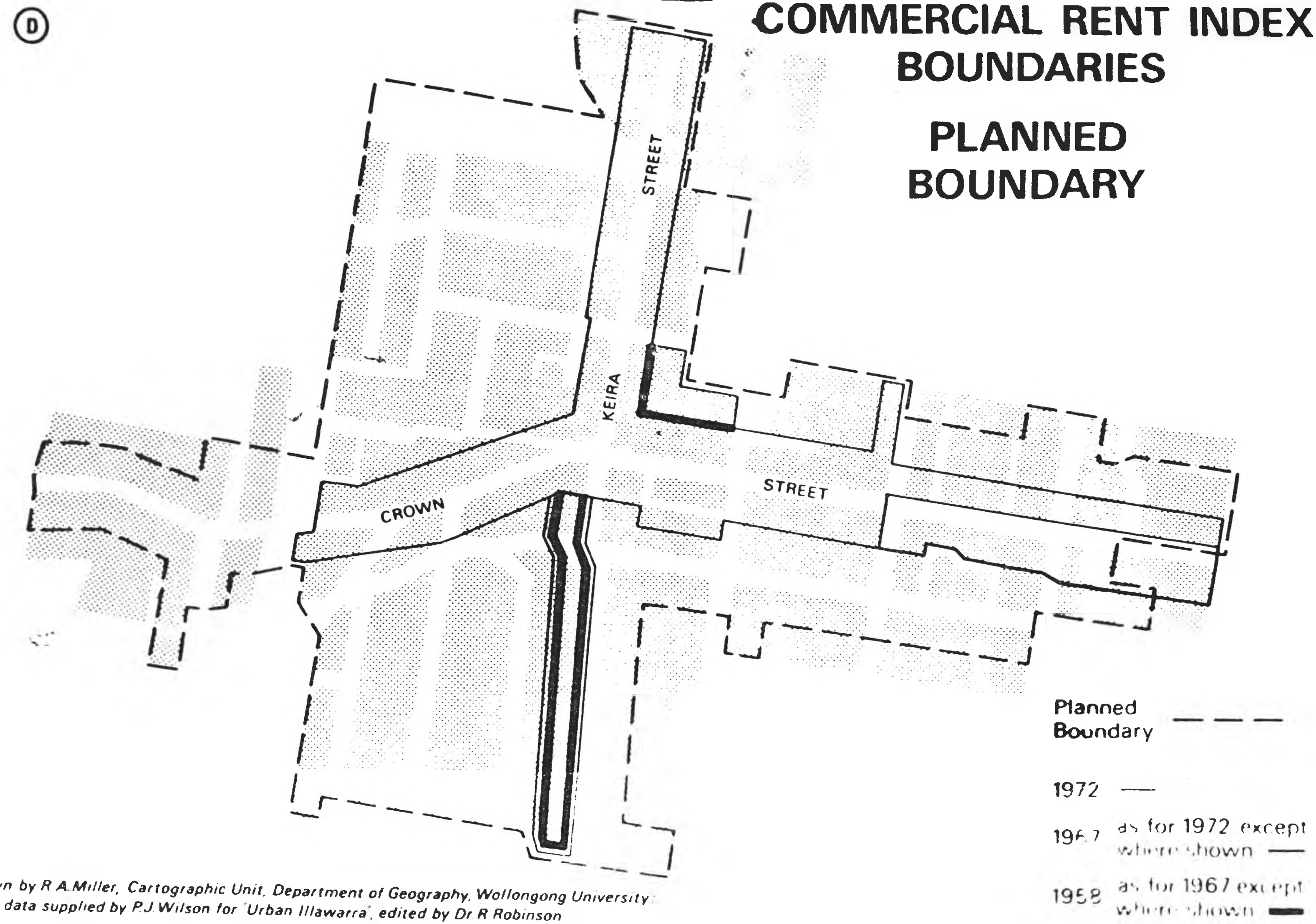
1962 as for 1967 except where shown ——

1958 as for 1967

Map 4

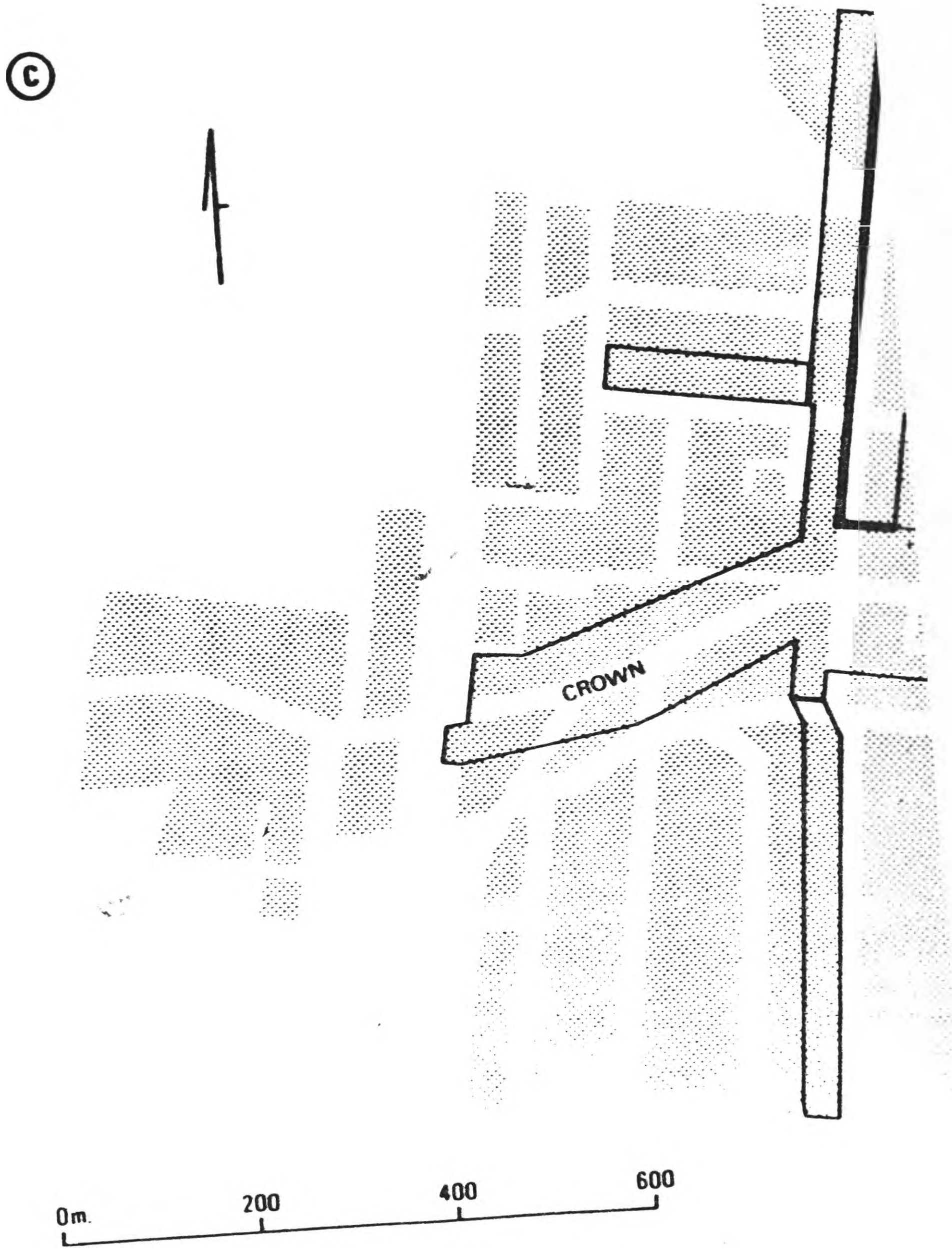
COMMERCIAL RENT INDEX BOUNDARIES

PLANNED BOUNDARY

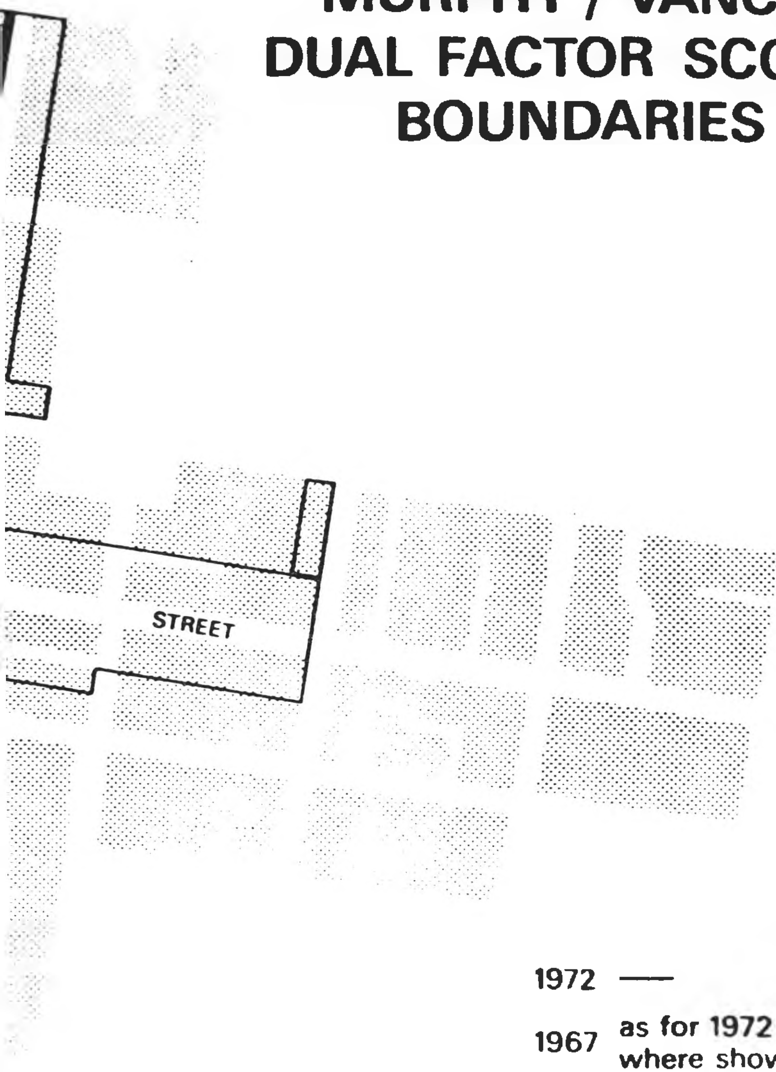


Drawn by R.A.Miller, Cartographic Unit, Department of Geography, Wollongong University from data supplied by P.J.Wilson for 'Urban Illawarra', edited by Dr R Robinson

Map 5



MURPHY / VANCE DUAL FACTOR SCORE BOUNDARIES



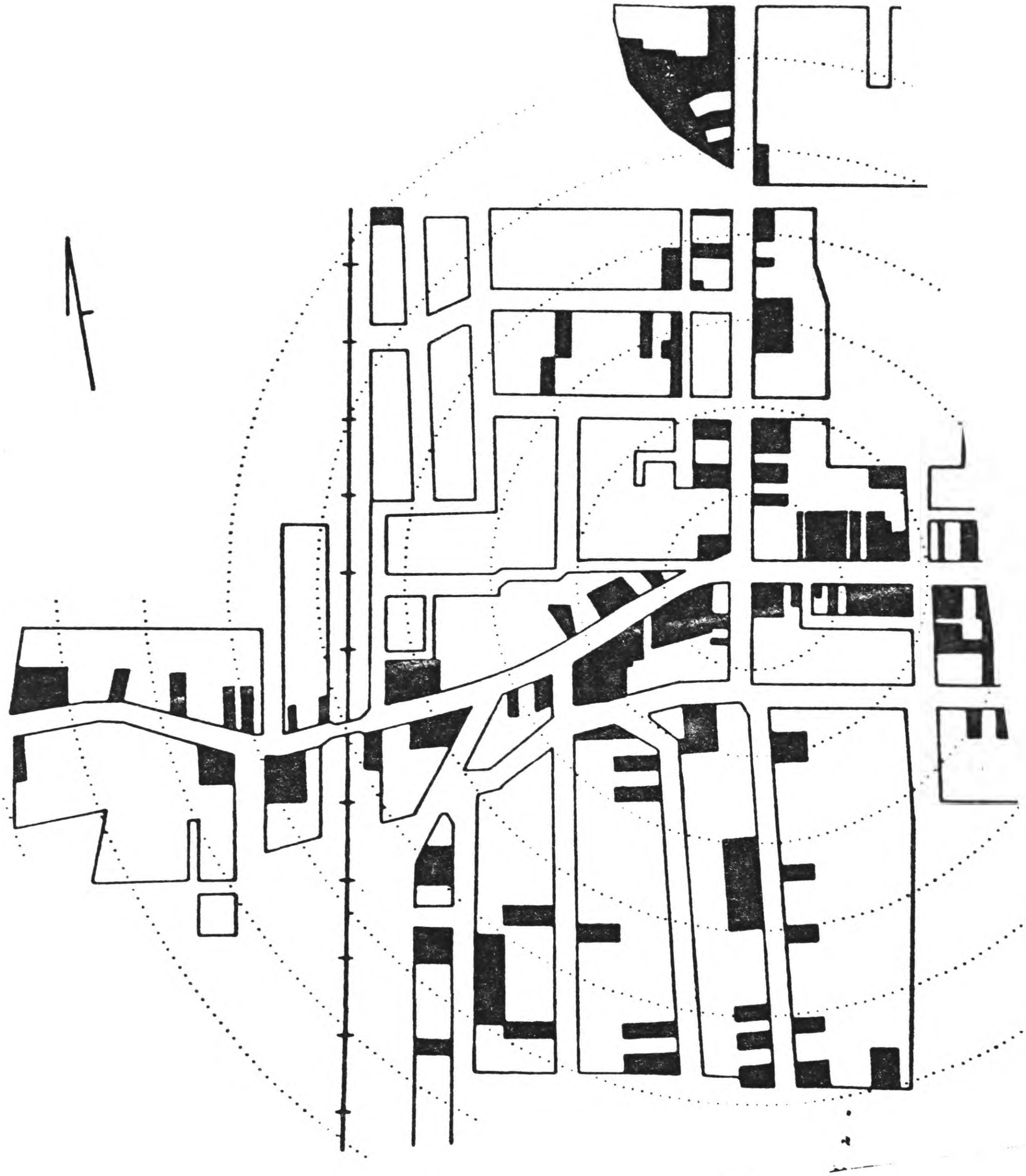
1972 ——

1967 as for 1972 except where shown ——

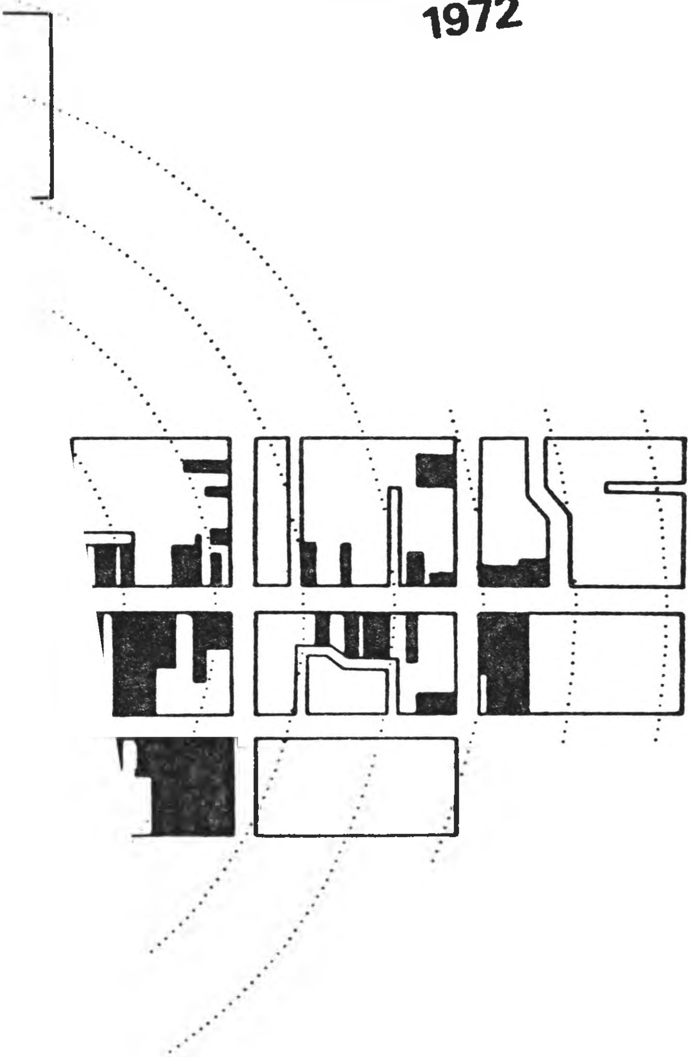
1962 as for 1967 except where shown ——

1958 as for 1962

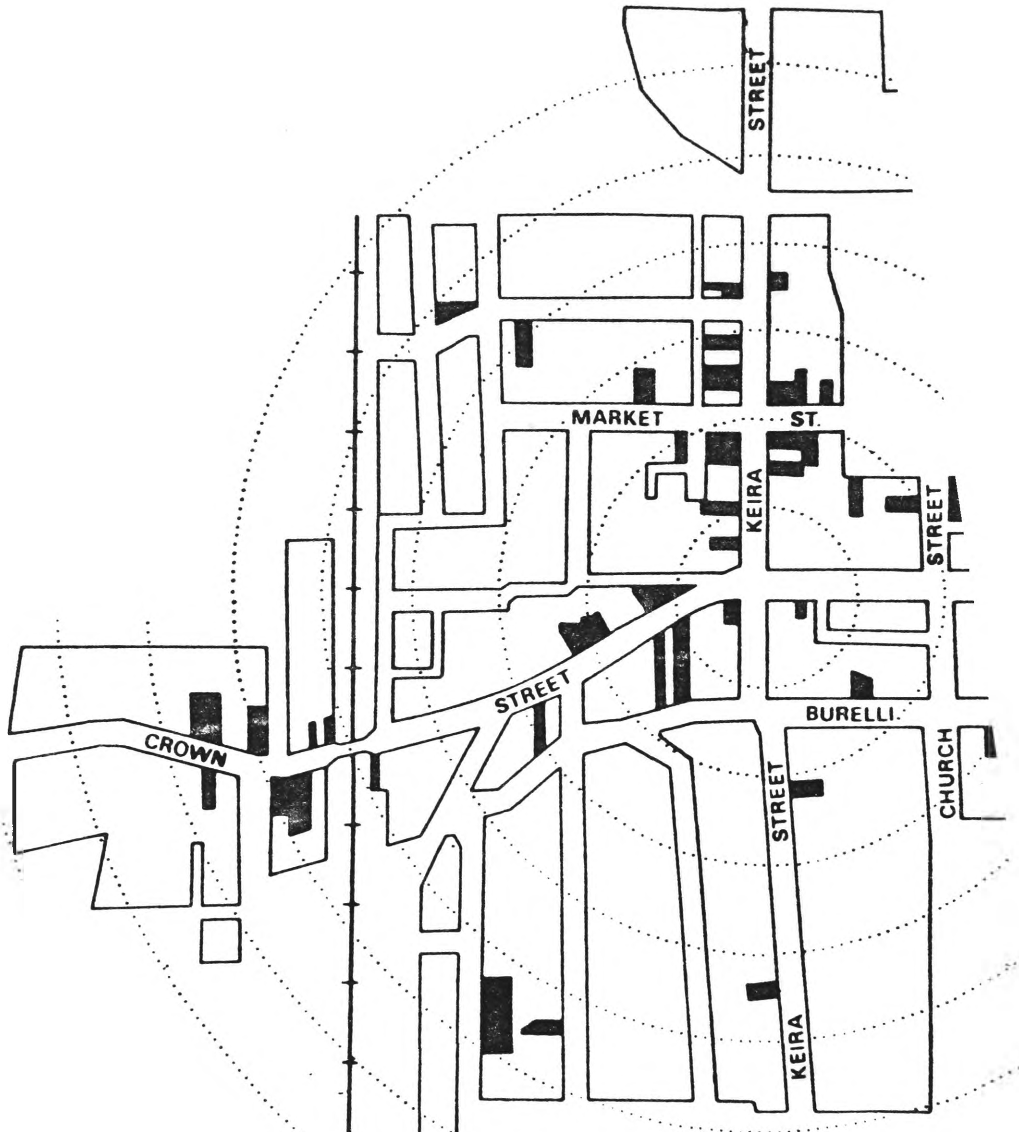
Map 6



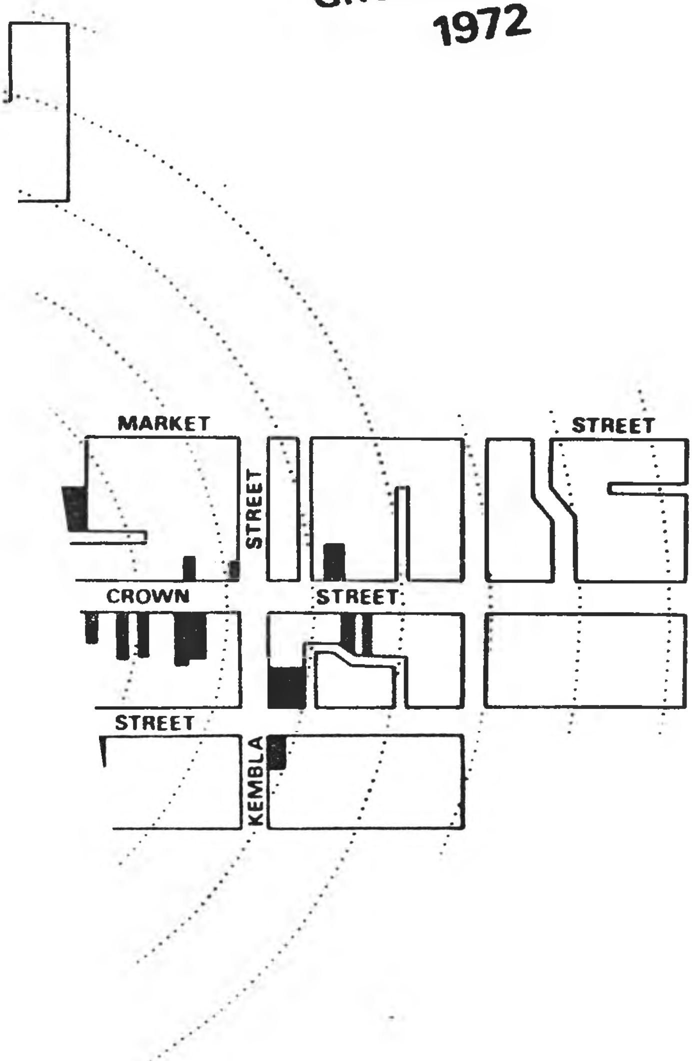
RETAIL DISTRIBUTION
GROUND FLOOR
1972



Map 7


STREET
MARKET
ST.
KEIRA
STREET
STREET
CROWN
BURELLI
STREET
CHURCH
KEIRA

OFFICE DISTRIBUTION
GROUND FLOOR
1972



Map 8

DISTRIBUTION OF OTHER LANDUSE TYPES GROUND FLOOR 1972

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